Household Take-up of Subsidized Insurance*

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Abstract

How households will respond to reforms of public insurance programs is unclear given recent behavioral findings on consumers' insurance choices. We examine the insurance decisions of an extremely vulnerable group in the U.S. National Flood Insurance Program. Severe repetitive loss (SRL) properties account for only 1% of policies but 25–30% of flood claims. Congress passed a reform that phases out the premium subsidies offered to this group over several years such that their premiums will eventually equal their contract's actuarially fair rate. We measure the effect of the reform using difference-in-differences estimation on a panel of over two million policy-year observations. We find that about one fourth of SRL property owners decided to stop insuring in response to the reform. We examine potential explanations of our results and find evidence of a behavioral response: consumer non-renewals closely correspond to periods of negative media coverage of the reform. Our findings add to research on public policy design and offer insights into insurance demand.

Keywords: Public Programs · Public Policy Design · Insurance Choices

JEL Classifications: D81 · G22 · H31 · H53

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1 Introduction

Policymakers occasionally decide to reform the public programs on which vulnerable groups rely. For example, recent reforms have affected programs covering the health risks of diabetics, the flood risks of residents in coastal communities, and the longevity risks of low-skilled workers. Because such programs are often expensive to uphold, they commonly feature partial subsidies for those covered: enrollees have to pay premiums to cover parts of the costs of the programs (Finkelstein et al., 2019). Such policy design is attractive from a theoretical standpoint. As long as premiums remain below the actuarially fair rate, classic models predict that reducing subsidies would not meaningfully affect households' insurance coverage (Mossin, 1968). Partial subsidies are also a potential remedy for market failures due to adverse selection (Einav and Finkelstein, 2011). Thus, carefully designed reforms might reduce the generosity of public programs without undermining the policy goal of protecting the vulnerable. However, empirical research on consumers' insurance decisions shows that households often have a willingness to pay far below their expected losses (Browne et al., 2015; Finkelstein et al., 2019; Wagner, 2020). While there are some indications as to why this low willingness to pay persists, the exact mechanism is still unclear. Uncovering it and getting a clearer picture of how households respond to reforms in public programs thus has important implications for designing effective policies.

Low participation in public insurance programs with partial subsidies can, in principle, be explained by adverse selection (Einav et al., 2010). However, neither Finkelstein et al. (2019) in health insurance, nor Wagner (2020) in flood insurance find sufficient evidence of adverse selection to explain a meaningful part of the gap. The underestimation of expected losses has often been discussed as a potential alternative explanation (Browne et al., 2015; Finkelstein et al., 2019; Wagner, 2020) but there is no empirical study which can directly link this explanation to the underinsurance phenomenon.[1] In this study, we examine the insurance decisions of a vulnerable group in the U.S. National Flood Insurance Program (NFIP) and a reform that reduces the premium subsidies offered to this group. Using detailed policy-level data and a difference-in-differences analysis, we analyze the impact of reduced partial subsidies on flood insurance demand. As in previous studies of the issue, we find strong demand reactions to decreases in the subsidy. While some adverse selection is detectable in the market, the effect is too small to explain the full demand reaction. Different from previous studies, however, we can exclude an effect of risk misperception as the driving cause of the result. When announcing the price increase to the policyholders, the

[1] Spinnewijn (2015) finds strong evidence for overly optimistic beliefs about expected losses in unemployment insurance. This finding motivates further research on the issue, but cannot establish a connection to underinsurance itself, because the analyzed unemployment insurance market is mandatory.

NFIP explicitly informed the affected group that they were still paying significantly less than their actuarially fair rate.

We then proceed to discuss other potential explanations for the observed demand reaction. Explanations discussed in the previous literature include liquidity constraints (Casaburi and Willis, 2018; Ericson and Sydnor, 2018; Rampini and Viswanathan, 2019), cheaper repair markets without insurance (Finkelstein et al., 2019), and errors in insurance choices (Handel and Kolstad, 2015; Bhargava et al., 2017). We find no evidence indicative of liquidity constraints playing a role. Demand reactions do not differ between less or more affluent geographic regions. Moreover, while we see strong demand reactions on the extensive margin, there is no discernible reaction on the intensive margin. If customers were truly liquidity constrained, they could adjust the coverage limits of their policy to offset any premium increases and still maintain some measure of financial protection.[2] We further argue that large differences in repair market prices for insured and uninsured losses are unlikely to appear in housing construction. While such effects likely play a role in health insurance, they are much less probable in flood insurance.[3]

We do, however, find indicative evidence that choice errors in the form of information frictions (e.g., Handel and Kolstad, 2015) or behavioral demand factors (e.g., Barseghyan et al., 2013), could play a role in explaining our results. Demand reactions are less pronounced in geographical regions with higher average educational attainment, a demographic characteristic linked to the prevalence of behavioral biases (Stango and Zinman, 2019). We also see a difference in the demand reaction by the affected and the unaffected group to a premium increase which took place after the reform was passed but before it took affect and that affected both groups equally. This shows a lack of understanding of the insurance program by some of the affected policyholders. Our findings on choice errors are, however, only indicative and thus not conclusive. We discuss the additional research necessary to fully identify the causes for underinsurance in subsidized insurance markets.

Our empirical setting is the U.S. market for residential flood insurance. The NFIP is the provider of almost all residential flood insurance in the U.S. and has a policy goal that at-risk populations are covered against severe losses.[4] Toward this goal, the NFIP frequently subsidizes

[2] See Finkelstein et al. (2019) for a similar argument against a strong effect of liquidity constraints in their study of health insurance choices.

[3] A related explanation for low insurance demand is charity hazard (Browne and Hoyt, 2000) which proposes a crowding out of insurance demand due to public relief funds. We argue that this is an unlikely explanation of the lacking insurance demand, mostly because public relief funds are limited by law and even more limited in practice and because empirical evidence for charity hazard is scarce.

[4] Households are pervasively underinsured against catastrophes: over 70% of disaster losses in the last decade were uninsured (Swiss Re, 2018). The U.S. Federal Emergency Management Agency (FEMA), which manages the NFIP, describes this policy goal as follows: "FEMA is committed to closing the insurance gap across the nation [...] One of [its

insurance for older and riskier properties. The largest subsidies accrue to "severe repetitive loss properties" (SRL properties), a set of homes which account for only 1% of policies but make up 25–30% of total claims payments in the NFIP (GAO, 2010). Before the reform, SRL properties properties paid, at most, 35–40% of the actuarially fair premium for their insurance (GAO, 2008). The NFIP has operated at an increasingly worsening deficit since Hurricane Katrina and currently has an outstanding debt of $20.5bn (FEMA, 2018b). Out of concern that the NFIP had become too generous, Congress passed the Biggert-Waters Flood Insurance Reform Act of 2012 (Biggert-Waters), which authorizes rate increases on some NFIP policyholders to "ensure the fiscal soundness of the program" (FEMA, 2019). Beginning 1 October 2013, Biggert-Waters increased the premiums of SRL properties by 25% each year until the actuarially fair premium for the SRL property is reached.

We examine in what way Biggert-Waters affected the insurance demand of SRL property owners. Our data include both SRL and non-SRL properties, and have more than 1 million policy-year observations from 2010 to 2018. Before the reform, a group of non-SRL properties was charged identical premium rates as a group of SRL properties, but their rates diverge after the reform. We employ difference-in-differences estimations using the group of non-SRL properties as a control group. Consistent with previous literature, we find that policyholders react strongly to a decrease in subsidies. About one fourth of SRL property owners decided to stop insuring in response to the Biggert-Waters reform in the two years after its passage. We use the model of Einav et al. (2010) to show that only about XX% of this reaction can be attributed to adverse selection. Interestingly, the decrease began after the law was passed, but before SRL and non-SRL properties were charged different prices. Also, all our results appear on the extensive margin. On the intensive margin, almost no differential behavior between the SRL properties and the reference group can be observed.

As outlined above, our paper adds to recent contributions in the literature on insurance demand. Five different explanations are typically levered for underinsurance in subsidized insurance schemes: adverse selection, risk misperception, liquidity constraints, uncompensated repair markets, and errors in the choice process of policyholders. Consistent with previous literature (Finkelstein et al., 2019; Wagner, 2020) we find adverse selection to be an insufficient explanation of demand reactions. In addition to previous results, we can exclude risk misperception as the driving force. Of the three remaining explanations, we find errors in the decision process of the policyholders to be the most likely cause of the underinsurance. However, further research is necessary to fully establish this result. It is also obvious that the explanation uncovered here is po-

strategic] goals is creating a culture of preparedness, which includes an ambitious 'moonshot' to double the number of properties covered by flood insurance by 2022. Plain and simple, we need more insured survivors." (FEMA, 2018a).

tentially idiosyncratic to flood insurance markets, because insurance markets differ substantially in their institutional factors. For flood insurance, however, while our evidence on the matter is not conclusive, we think that research should focus on errors in the decision process of policyholders as the most likely candidate for explaining a lack of demand.

Based on this perspective, our findings add to research on public policy design. A recent strand in this literature considers how to design public policy for settings in which behavioral factors may guide households' choices (see Chetty, 2015; Handel and Schwartzstein, 2018; Farhi and Gabaix, 2020). In such a setting, the decision utility (incorporating choice errors) differs from the experienced utility (according to a canonical model). If decision utility considerations let policyholders drop their coverage even if still subsidized, the expected experienced utility decreases. Our findings thus suggest a tradeoff to designing insurance subsidies which is not captured in canonical models. From the perspective of increasing the financial sustainability of a public program, Biggert-Waters appears to be a success: it reduced the subsidy rate of participants in the NFIP's risk pool. However, a longstanding, fundamental goal of disaster policy – and the *raison d'etre* of the NFIP – is that vulnerable populations are insured.[5] Thus, households' tendency to drop their insurance in response to the reform appears to exacerbate a larger public policy problem, that many households do not insure against catastrophes, which may outweigh the benefits of the reform.

In the following, we first summarize the institutional background of the NFIP and the Biggert-Waters Reform Act. We then give an overview of the data used in this study. The third section reports the main results of our analysis. Section four discusses and analyses potential causes of the observed demand reactions. The paper concludes with a discussion of the results and their implications in section four.

2 Background

2.1 Institutional details

Congress established the NFIP in 1968 due to a lack of flood insurance offerings in the private insurance market (Michel-Kerjan, 2010). Today, standard homeowners insurance continues to exclude flood risk and the NFIP provides 95% of residential flood insurance in the U.S., insuring

[5] According to FEMA, insurance allows households to recover more quickly and fully from a shock and reduces government spending on relief (FEMA, 2013; FEMA, 2018a). This spending arises because households can apply for federal disaster grants to receive up to $34,000 in 2018 dollars for uninsured losses, though the average grant is around $5,000. FEMA also provides in-kind relief such as temporary shelter.

over 4 million households a year (Kousky et al., 2018).

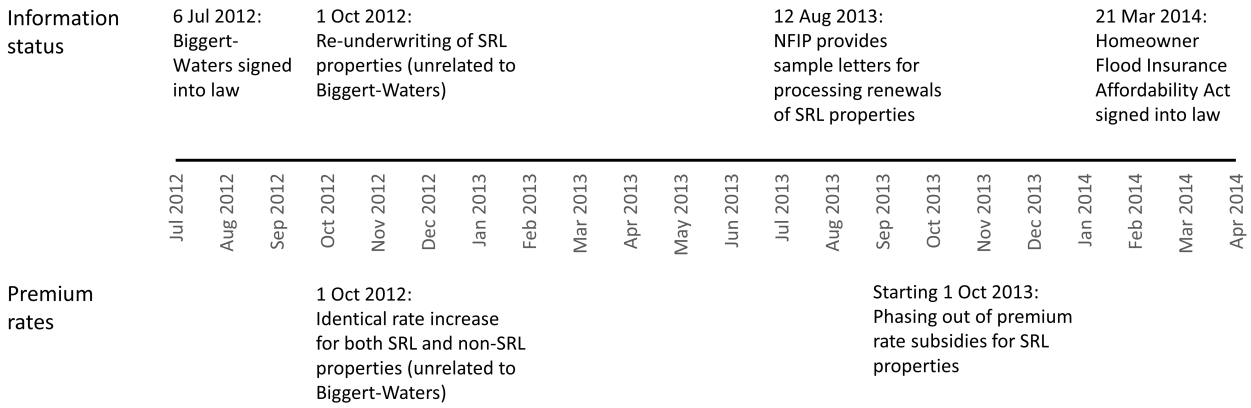
The NFIP designs its insurance contracts, determines premium rates, and bears the claims risk. The Federal Emergency Management Agency (FEMA) administers the NFIP and develops and maintains flood insurance rate maps (FIRM), which identify flood zones. These flood maps influence building codes. For example, codes require new homes that are built in flood zones to be elevated. Homes built before local flood maps were developed (pre-FIRM homes) tend to be at greater risk as they often were not constructed with flooding in mind. The program has tended to offer preferential rates to pre-FIRM homes. It calculates their premium rates using methods that are less risk sensitive than the rating used for newer (post-FIRM) homes. For example, a property's elevation significantly influences the premium rates of post-FIRM homes but not pre-FIRM homes.

The largest subsidies accrue to SRL properties. SRL properties are a specially designated group of properties that flood frequently. Using claims records beginning in 1978, the NFIP defines SRL properties as those with four or more claims payments of more than $5,000 each within a ten-year period. On 6 July 2012, President Obama signed the Biggert-Waters Flood Insurance Reform Act into law, which began phasing out premium subsidies for pre-FIRM, SRL properties starting 1 October 2013. Biggert-Waters increased the premium rates on these properties by 25% each year independent of a loss occurrence until the actuarially fair premium is reached.[6]

Figure 1 displays a timeline of the Biggert-Waters Reform Act. Although SRL and non-SRL properties were charged identical premium rates until 1 October 2013, they differed in their information status about future premium increases after the passage of the law on 6 July 2012. After Biggert-Waters was signed into law but before SRL and non-SRL properties were charged different premium rates, both SRL and non-SRL property owners faced an identical premium rate increase on 1 October 2012. At the same time and unrelated to Biggert-Waters the NFIP required agents to re-underwrite SRL properties (e.g., update home characteristics, take photos of the front and rear) for policies that renew on or after 1 October 2012. From 1 October 2013 on, Biggert-Waters implemented premium rate discrimination between SRL and non-SRL properties by phasing out SRL property owners' subsidies. The Homeowner Flood Insurance Affordability Act (signed into law on 21 March 2014) repealed and modified parts of Biggert-Waters. In our sample (see Section 2.3.2), however, neither were non-SRL properties affected by Biggert-Waters nor were SRL properties affected by the repeals.

[6] This Reform Act also removed subsidies for other properties. For example, before Biggert-Waters, in the case of rate map changes policyholders could under certain circumstances keep the rating based on their old flood zone if more favorable to them. The Reform Act of 2012 phased out these so called "grandfathered" rates. The Consolidated Appropriations Act of 2014, however, delayed the phasing out of "grandfathered" rates.

Figure 1: Timeline of the Biggert-Waters Reform Act



Notes: The figure displays a timeline of the Biggert-Waters Reform Act. Until 1 October 2013, SRL and non-SRL properties are charged identical premium rates. Starting 6 July 2012, SRL and non-SRL properties differ in their information status about future premium increases.

2.2 Information Dissemination

This timeline raises questions regarding when policyholders who would be affected by Biggert-Waters learned about it. We examine two information channels: official communications from the NFIP and media coverage. We found two official communication documents. One was a letter to insurance agents, dated 7 July 2012, which noted the passage of Biggert-Waters. The second occurred at least 13 months later and was a direct communication with policyholders via the renewal letter. Beginning 12 August 2013, SRL property owners got detailed information on these rate increases through renewal letters sent out to arrive 45 days before policy expiration. That letter states:[7]

> "The Biggert-Waters Flood Insurance Reform Act of 2012, phases out subsidized rates for certain properties, including Severe Repetitive Loss (SRL) properties. Our records indicate that your building is an SRL property, and you have been paying a subsidized rate.
>
> Starting October 1, 2013 (...) your premium must increase 25 percent each year until it reaches the full-risk rate. The enclosed renewal bill reflects the statutorily-required 25 percent increase."

We searched media coverage from the enactment of Biggert-Waters (July 2012) to the enactment of the Homeowner Flood Insurance Affordability Act (March 2014) using a variety of rele-

[7] See Appendix B for the full letter.

vant terms. Very few articles were written about Biggert-Waters within 3 months of its passage. In July 2012, we found an article in *The Times-Picayune* of New Orleans and one in the industry outlet *Insurance Journal*, both noting that Biggert-Waters would phase out subsidies for SRL properties: "Second homes, properties with repetitive losses and commercial properties must be charged actuarially sound rates. The rates will be phased in over five years in 20 percent increments by calculating the difference between the current rate and actuarial rates." (The Times-Picayune, 2012).

While public debate was limited just after the ratification of Biggert-Waters, this changed after Hurricane Sandy (September 2012) when TV news reported about recovery in New York and New Jersey (Verchick and Johnson, 2014). In an effort to make the new insurance pricing transparent for agents and policyholders, FEMA released a document including an example with a post-reform premium of $28,000 (Herald Guide, 2013). Due to negative news coverage FEMA deleted this document from their website and clarified that this example is not representative for the vast majority of buildings (Claudet, 2013). On 6 June 2013, congresswoman Maxine Waters gave a speech to the U.S. House of Representatives and initiated to modify the reform:

> "(...) I worked across the aisle with my colleague, Rep. Judy Biggert, to reauthorize this program. (...) The intent was not to impose punitive or unaffordable rate hikes that could make it difficult for some to remain in their homes. (...) I look forward to continuing (...) to ensure that Biggert-Waters Act is implemented in a balanced way to ensure the flood insurance program's stability and affordability. FEMA's current implementation schedule could upset that delicate balance and unintentionally impact families and local communities (U.S. House Committee on Financial Services, 2013)."

The uncertainty about future flood insurance premiums also affected the real estate market (Skumanick, 2013). The President of the Pennsylvania Association of Realtors argues that FEMA may have waited to long to publish accurate information on the impact of Biggert-Waters on future pricing. This confused insurance agents and affected market values for home purchases: "[O]ne buyer received six different quotes ranging from $10,000 to $30,000 per year; three of those came from different agents for the same company. All six insurance agents provided inaccurate information about the property and mistakes drove the quotes. When the correct data was entered, the true rate was about $480 per year, which was confirmed by FEMA. (Skumanick, 2013)"

Media coverage was most active from the summer of 2013 through the implementation of the law in October. Some articles described the phasing out of subsidies: "Businesses, vacation homes and homes with 'repetitive' flood losses will see rates rise 25% a year until those 'rates reflect

true risk' (The Wall Street Journal, 2013b). Others were a call for alarm: "Mr. Bubrig estimated that flood-insurance premiums on his home will increase from $633 to $28,000 a year, with a big chunk of the increase hitting as early as 2014" (The Wall Street Journal, 2013a). In early March 2014, media coverage of Biggert-Waters increased again due to the passage of the Homeowners Flood Insurance Affordability Act as it repealed some elements of Biggert-Waters. Those articles frequently describe Biggert-Waters as unpopular and raise concerns about its adverse effects on real estate values.[8]

In summary, policyholders were informed about the passage of Biggert-Waters through several channels. Direct communication and industry publications suggest that agents may have been some of the first stakeholders aware of the reform, which they might have described to policyholders before the NFIP contacted policyholders. Direct communication from the NFIP to policyholders and detailed media coverage describe the subsidy reductions and convergence to the actuarially fair rate. Still, media coverage also depicted skyrocketing rates and "outrage" over these price increases. Communities then presented these skyrocketing rates to their members, potentially contributing to a perception that the reform was unfair to policyholders (Claudet, 2013).

2.3 Data

2.3.1 Overview of databases

We use two databases in our analyses, both collected and maintained by the NFIP. The first database is policy-level panel data, including both SRL and non-SRL properties from 2009 to 2018. It shows the insurance choices (e.g., the selected coverage limit) and filed claims of each policyholder by year. We compare policyholders' insurance choices across time and groups in this database to understand the effects of the reform.

The second database describes each SRL property as of 2018. It is cross-sectional, showing the current status of the property such as whether the home has been demolished but not when any changes to the property occurred. These data represent an end-line in our policy analysis, describing SRL properties about five years after the October 2013 implementation of Biggert-Waters.

[8] We describe our media search in more detail and provide additional illustrative excerpts from local and national outlets in Appendix C.

2.3.2 Policy-level, panel data

Our panel data include residential flood insurance policies on privately-owned properties in the NFIP's Regular Program.[9] These data provide policyholders' coverage limit and deductible choices, home characteristics (e.g., number of floors, whether the home has an elevation certificate, obstruction, etc.), location characteristics (zip code, community, etc.), and other pricing relevant variables. The data also include both SRL and non-SRL properties and an indicator designating SRL properties. For our primary analyses we examine the renewal and coverage choices of policies that were in force in 2009, the year our data begin, and track these policies over time. For example, these analyses do not include new policies that enter the program in 2010.[10]

The data include over 5 million policies in 2009. Table 1 provides the steps to restrict the data to the group of SRL and non-SRL properties that were charged identical premium rates before Biggert-Waters but different rates afterward. We call properties in this subset the "Restricted Sample." The Restricted Sample is properties that are single-family homes that serve as a primary residence, are located in A flood zones, and have a pre-FIRM rating. Properties located in A flood zones (A, AE, A1–A30, AO, AH) lie in the non-coastal areas, which are not vulnerable to wave damage from storm surge, but are estimated to have at least a one percent annual probability of flooding. In total, the Restricted Sample includes 476,627 unique policies, 2,050 of which are designated SRL. We follow this 2009 cohort of policies until 2018, which provides us with more than 2 million policy-year observations to analyze their insurance choices.

Table 1: Sample selection process

Step	Description	Policies
0	All policies in 2009	5,002,696
1	Keep if single family home	4,245,726
2	Keep if primary residence	3,586,375
3	Keep if flood zone is A, AE, A1–A30, AO, AH	1,936,661
4	Keep if rated as a pre-FIRM property	476,627
Restricted Sample		**476,627**

Notes: The table describes the steps of the sample selection process and outlines the number of policies kept with each data cleaning step.

[9] In addition to insuring privately-owned residential properties, the NFIP insures nonresidential properties (e.g., businesses) and publicly owned residential properties (e.g., public housing), which are not part of our study. In addition to the Regular Program, the NFIP manages an Emergency Program, which is the initial phase of a community's participation in the NFIP. After completion of certain requirements the communities can join the Regular Program (NFIP, 2014). The Emergency Program represents a small number of policies in the NFIP in 2009.

[10] As a robustness check we similarly analyze the 2010 cohort (see Table 15 and Table 17 in Appendix I).

2.3.3 Effect of Biggert-Waters on premium ratings

Homeowners can separately choose building coverage $c^{(b)}$ and contents coverage $c^{(c)}$ up to a limit of \$250,000 for buildings and \$100,000 for contents in our data. The premium p for NFIP's flood insurance policy depends on these insurance choices and is calculated as follows:

$$\text{Building:} \quad p^{(b)} = \min\left(c^{(b)}, 60000\right) \cdot r_b^{(b)} + \max\left(c^{(b)} - 60000, 0\right) \cdot r_a^{(b)} \tag{1}$$

$$\text{Contents:} \quad p^{(c)} = \min\left(c^{(c)}, 25000\right) \cdot r_b^{(c)} + \max\left(c^{(c)} - 25000, 0\right) \cdot r_a^{(c)} \tag{2}$$

$$\text{Total:} \quad p = \left(\left(p^{(b)} + p^{(c)}\right) \cdot \delta + icc\right) \cdot crs + f \tag{3}$$

In the above formula $r_b^{(b)}$ denotes the premium rate for building coverage limits up to \$60,000, called "basic building coverage", and $r_a^{(b)}$ designates the premium rate for the additional coverage exceeding \$60,000. Similarly, $r_b^{(c)}$ denotes the premium rate for basic contents coverage until \$25,000 and $r_a^{(c)}$ for additional coverage exceeding \$25,000.

The sum of the premium for building $p^{(b)}$ and contents coverage $p^{(c)}$ is multiplied by a deductible factor δ. NFIP's rating manual provides these deductible factors. For example in January 2012, the minimum deductible option of \$1,000 had a $\delta = 1.1$ while the maximum deductible option of \$5,000 had a $\delta = 0.81$. The policy's premium further comprises a Community Rating System (crs) discount for the respective communities' engagement in mitigation measures, an administrative fee f, and a fee icc as a contribution to the increased cost of compliance program that helps policyholders bring their properties to current building standards after a loss occurrence. In 2010, the median crs discount, administrative fee f, and icc fee are 0.9, \$40, \$64 for the non-SRL properties and 1, \$40, \$64 for the SRL properties in the Restricted Sample. The difference between SRL and non-SRL properties in the median crs discount is due to differences in community affiliations.

The Biggert-Waters Reform Act increased the premiums of the SRL property owners in the Restricted Sample. Specifically, Biggert-Waters increased the building and contents coverage rates, $\{r_b^{(b)}, r_a^{(b)}, r_b^{(c)}, r_a^{(c)}\}$. Table 2 shows the development of building premium rates, $r_b^{(b)}$ and $r_a^{(b)}$ over time for properties without a basement, which represents 75% of both SRL and non-SRL properties in the Restricted Sample. SRL properties with basements experienced similar rate increases due to Biggert-Waters (shown in Appendix E, Table 13). For example in January 2013, prior to the implementation of Biggert-Waters in October, policyholders in the Restricted Sample with no basement paid $r_b^{(b)} = 0.0076$ and $r_a^{(b)} = 0.0077$ per dollar of coverage. Following Biggert-Waters, premium rates increased for SRL properties to $r_b^{(b)} = 0.0091$ and $r_a^{(b)} = 0.0092$ versus $r_b^{(b)} = 0.0091$

Table 2: Development of building rates over time

Effective date	SRL properties		Non-SRL properties	
	$r_b^{(b)}$	$r_a^{(b)}$	$r_b^{(b)}$	$r_a^{(b)}$
2008-10-01	0.0076	0.0054	0.0076	0.0054
2009-10-01	0.0076	0.0057	0.0076	0.0057
2010-05-01	0.0076	0.0056	0.0076	0.0056
2010-10-01	0.0076	0.0060	0.0076	0.0060
2011-10-01	0.0076	0.0066	0.0076	0.0066
2012-10-01	0.0076	0.0077	0.0076	0.0077
Implementation of Biggert-Waters for SRL properties				
2013-10-01	0.0091	0.0092	0.0091	0.0077
2014-10-01	0.0091	0.0092	0.0085	0.0078
2015-04-01	0.0103	0.0105	0.0089	0.0081
2016-04-01	0.0129	0.0131	0.0094	0.0085
2017-04-01	0.0161	0.0164	0.0099	0.0090
2018-04-01	0.0201	0.0205	0.0104	0.0095

Notes: The table displays the development of building rates in the Restricted Sample for properties without a basement. It shows the rate $r_b^{(b)}$ for basic building coverage until \$60,000 and the rate $r_a^{(b)}$ for additional building coverage above \$60,000 for both SRL and non-SRL properties between October 2008 and December 2018.

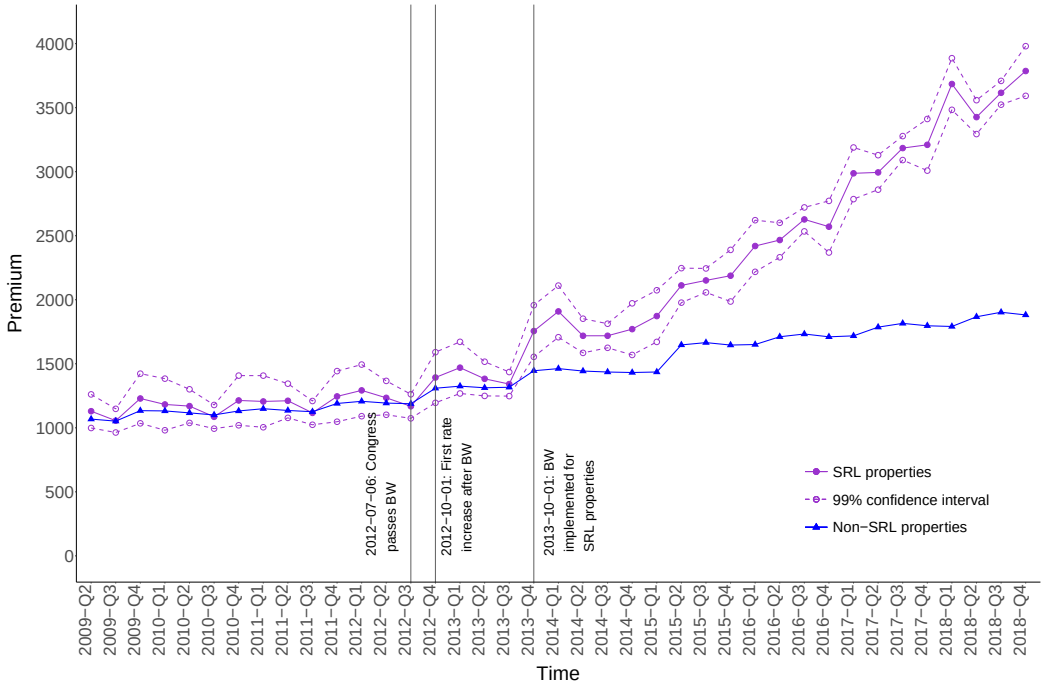
and $r_a^{(b)} = 0.0077$ for non-SRL properties. Thus, both SRL and non-SRL properties experienced a premium rate increase for the basic building coverage until \$60,000 but only SRL properties faced an increase for the additional building coverage above \$60,000. In subsequent years, due to Biggert-Waters, SRL properties experienced additional increases, approximately tripling their pre-reform rates, while rates for non-SRL properties changed only moderately, by comparison.

Figure 2 shows the development of the mean premium for the subset of 2009 properties that continued to insure at the end of the panel dataset. Comparing the graphs for SRL and non-SRL policyholders shows that mean premiums exhibit significant deviances starting the implementation of Biggert-Waters in 2013-Q4 (see the 99% confidence intervals). At the end of the panel data set, in 2018, the mean premium for SRL property was \$3,771, about 88% more than the mean premium for non-SRL properties.

2.3.4 Home and policy characteristics

Table 3 shows summary statistics on insurance choices and home and policy characteristics for SRL and non-SRL properties in 2009. First, we look at insurance choices. SRL and non-SRL properties exhibit similar building coverage (\$140,373 versus \$142,840). SRL property owners are, how-

Figure 2: Premium development between 2009 and 2018



Notes: Development of the mean premium for the subset of 2009 properties that continued to insure at the end of the panel dataset is displayed. For the sake of comparability, building coverage is fixed to $140,000 and contents coverage is fixed to $20,000.

ever, more likely to purchase contents coverage. In terms of deductibles, the NFIP provides default options. The policyholder can choose a deductible equal, below or above this default deductible. In 2009, the default deductible in the Restricted Sample was $1000. SRL and non-SRL property owners did not markedly differ in their deductible choices with the majority of both choosing the default deductible of $1000.

Second, the table provides information on home and policy characteristics, which we use as control variables in Section 3. SRL and non-SRL properties exhibit similar elevation and construction characteristics, show similar CRS discounts, home age, and policy age. Further, we observe similar mean income on the ZIP code level among SRL and non-SRL property owners. SRL and non-SRL policies do, however, differ in their subsidization rates.[11] The median loading factor for SRL policies is 0.19, indicating large subsidies for a significant portion of SRL property owners. In contrast, the median loading factor for non-SRL policies is larger than 1, indicating above actuarially fair insurance rates. Figure 3 displays a histogram of loading factors for SRL and non-SRL

[11] Using claims-level, panel data between 2001 and 2012, we estimate loading factors for each property. Appendix G provides the details of our frequency-severity loss estimation model.

properties in 2009. 91% of SRL and 37% of non-SRL exhibit loading factors smaller than one, indicating subsidized insurance premiums.

Table 3: Summary statistics in 2009

	SRL properties (2,050)			**Non-SRL properties (474,577)**		
	Mean	St. Dev.	Median	Mean	St. Dev.	Median
Coverage choices						
Building Coverage	140,373	76,796	130,500	142,840	77,843	135,700
Contents Coverage	31,076	28,282	23,500	20,331	30,715	0
Has Contents Coverage	0.84			0.47		
Default Deductible ($1000)	0.64			0.53		
Deductible $<$ \$1000	0.19			0.20		
Deductible $>$ \$1000	0.17			0.27		
Control variables						
CRS Score	0.92	0.81	0.90	0.92	0.86	0.95
No. Floors	1.54	0.66	1	1.49	0.66	1
Home Age	47	16	42	49	18	45
Income (ZIP code)	74,513	33,840	66,881	71,323	30,772	63,139
Loading factor	0.49	2.81	0.19	3.94	17.50	1.49
Policy Age	3.73	3.17	3	5.94	5.66	4
Has Elevation Certificate	0.13			0.10		
Is Elevated	0.19			0.15		
Is Mobile Home	0.01			0.02		
Has Obstruction	0.20			0.23		

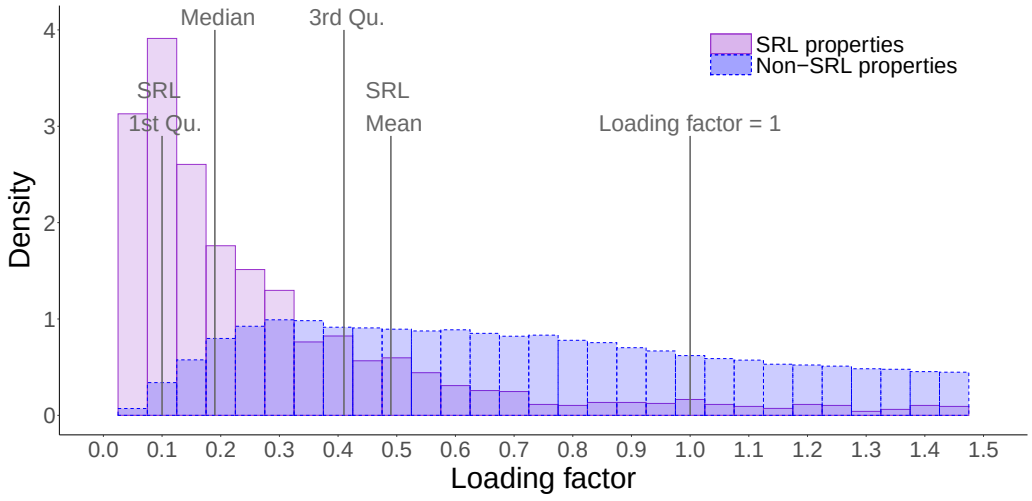
Notes: Summary statistics for SRL and non-SRL properties in the Restricted Sample in 2009 are displayed. Table 14 in Appendix 2.3.4 provides additional information on these variables.

2.3.5 Severe repetitive loss property database

The SRL Property Database includes all SRL properties up to 2018, a total of 36,774 homes. Table 4 describes these properties. The left panel of the table provides summary statistics for the full database. The properties are primarily single-family dwellings (82%) that were constructed pre-FIRM (86%) and lie in the A flood zones (75%). Interestingly, almost all of the remaining SRL properties (19%) are located in "low-risk" zones (A99, B, C, X), which FEMA estimates have an annual probability for flooding that is less than 1%. 4% of SRL properties are located in the V flood zones, which denote coastal areas subject to wave damage.

The median SRL property has received \$202,897 in total payments, the sum of all building and contents payments for this property since 1978. The median payment is \$28,669. The median property incurred 5 insured losses between 1978 and 2018; however, 20 properties faced 30 losses

Figure 3: Histogram of loading factors in 2009 (own estimates)



Notes: The distribution of loading factors for SRL and non-SRL properties in 2009 is displayed. 91% of SRL and 37% of non-SRL exhibit loading factors smaller than one, indicating subsidized insurance premiums. Appendix G provides additional information on our estimation of loading factors.

or more. One property located in Louisiana filed 40 claims, which correspond to approximately one loss per year. Another property, also located in Louisiana, filed 21 claims since 1978. Between 2009 and 2012 for example, this property worth $190,051 in building value faced 5 losses. For these losses NFIP paid $111,358 in total payments which correspond to an average of $27,840 each year. In contrast, the property faced an average premium equal to $940 in this period.

In addition, the database provides information on whether the risk of the property has been reduced through mitigation. We find that the risk had been reduced on 27% of SRL properties. About 10% of properties were either elevated or replaced with a new property that was elevated. About 14% were demolished. Typically, these properties were acquired by a government "buy-out" program. About half of these demolished properties were acquired through a federal program. A flood water management program reduced the risk of 1% of SRL properties.

The right panel shows the same statistics for the Restricted Sample, which totals 20,430 homes. As Section 2.3.2 describes in more detail, these properties are single family homes, constructed pre-FIRM, and located in flood zones A, AE, A1-A30, AO, AH and so represent the typical SRL property in the Restricted Sample.[12] The Restricted Sample also appears similar regarding its claims statistics, though the amounts are a little lower. While properties have also flooded a me-

[12] The SRL Property Database does not indicate whether the property is rated pre-FIRM but only if it was constructed pre-FIRM. Owners of pre-FIRM constructed properties may switch the rating to post-FIRM if this results in lower premiums. The data in Section 2.3.2 is thus a subset of the properties that we here call the "Restricted Sample".

Table 4: Descriptive statistics of severe repetitive loss properties as of 2018

	Unrestricted Sample (36,774)			Restricted Sample (20,430)		
Occupancy						
Single family			0.82			1
2-4 family			0.04			0
Other residential			0.02			0
Non residential			0.10			0
Unknown			0.01			0
Pre-FIRM Construction						
Yes			0.86			1
No			0.14			0
Flood Zone						
A, AE, A1-A30, AO, AH			0.75			1
V, VE, V1-V30			0.04			0
A99, B, C, X			0.19			0
Unknown			0.02			0
Claims Statistics	Claims Payments	Tot. Payment	Tot. No. Losses	Claims Payments	Tot. Payment	Tot. No. Losses
Mean	55,116	276,353	5	47,916	195,970	5
St. Dev.	114,304	357,417	3	57,914	155,566	3
Pctl(1)	2,072	28,860	2	2,065	8,825	2
Pctl(25)	12,630	126,962	4	12,498	91,654	4
Median	28,669	202,897	5	28,218	159,256	5
Pctl(75)	62,332	320,319	6	59,873	255,618	6
Pctl(99)	377,271	1,529,157	15	292,950	745,070	15
Type of Mitigation						
Building acquired and demolished as part of a program			0.08			0.10
Building elevated to or above BFE			0.07			0.09
Building demolished but not acquired through a federal program			0.06			0.07
Building replaced by a new elevated/floodproofed building			0.03			0.03
Building protected by a flood control/stormwater management project			0.01			0.01
Unknown			0.02			0.01
None			0.73			0.69

Notes: Statistics of SRL properties on characteristics, claims, and mitigation are displayed. Monetary amounts are converted into 2018 dollars.

dian of 5 times in the Restricted Sample, the median total payment is $159,256 versus $202,897 for the Unrestricted Sample. These differences may result from the Unrestricted Sample including some larger value properties, apartment buildings and small business buildings. The mitigation status looks very similar. For example, 69% of properties in the Restricted Sample are unmitigated (versus 73% for the Unrestricted Sample).

In summary, the SRL Property Database shows that, approximately five years after Biggert-Waters, most properties remained unmitigated (73%). Our data are limited in their ability to explain mitigation choices. Mitigation decisions depend on a complicated mix of unobserved variation in mitigation costs across homes, access to public funding (which can vary by municipality and state), access to private funds (e.g., access to credit), and the private value of mitigation (e.g., some homeowners may be unwilling or unable to live in a home that is elevated on stilts). Instead,

we examine households' insurance decisions in depth using policy-level panel data. In particular, we analyze how Biggert-Waters affected (1) policyholders' decisions to renew their insurance contract and (2) what coverage limit to select.

3 Insurance decisions

3.1 Renewal decisions

3.1.1 Identification and estimation

This section analyzes the effect of Biggert-Waters on renewal decisions of SRL properties using data from 2010 to 2018 including over 2 million policy-year observations. We consider the implementation of Biggert-Waters a natural experiment as it created a plausibly exogenous source of variation in insurance prices by increasing insurance premiums for pre-FIRM SRL property owners (treatment group) but not pre-FIRM non-SRL property owners (control group).[13] We study the effect of the policy change with a difference-in-differences estimation. This estimation strategy leverages the panel structure of our data. First, we observe the insurance choices of each policyholder across years and so can leverage time series variation. Second, we observe both the treatment and the control group and so can leverage cross-sectional variation. The combination allows us to construct a counterfactual regarding what insurance choices SRL property owners would make had the reform not occurred.

Using this counterfactual to estimate the treatment effect relies on two assumptions. First, we assume that, after the inclusion of controls, the responses of non-SRL properties capture common trends in the data. This first assumption indicates that if the reform had not occurred, the average change in renewal rates for the SRL properties following the reform would have been the same as the average change in renewal rates for non-SRL properties, after accounting for model controls. For example, if a macroeconomic downturn caused non-SRL properties not to renew following the reform, SRL properties would have similarly decided not to renew.[14] Second, we assume

[13] Biggert-Waters appears to be a good candidate for such a natural experiment. It was enacted in July 2012, a relatively quiet period in terms of flood claims, which was roughly 3 months before Hurricane Sandy occurred. The part of the law pertaining to SRL properties was but one element of a large law that affected NFIP policyholders outside of our study. Thus, its passages does not appear to have been precipitated by underlying changes to SRL properties that might interfere with our estimation of the reform's effect.

[14] Figure 9 in Appendix H shows the pre-reform renewal rates of the SRL and non-SRL properties and suggests support for the parallel trends assumption. While difference-in-differences estimation requires a common trend between treatment and controls, it does not require that the treatment and control groups are identical pre-treatment (Angrist and Pischke, 2008, Chapter 5), and we have reason to believe that SRL and non-SRL properties were not as the SRL properties had been previously identified as a vulnerable group by the NFIP.

that Biggert-Waters did not coincide with an additional change that might account for differences between SRL and non-SRL properties. We have been unable to identify changes concurrent with Biggert-Waters that affected only SRL properties or only non-SRL properties.

The empirical test for the effect of the reform on renewal decisions is a event study regression model of whether policyholder i renews her policy at time t as a function of the treatment group indicator ($\mathbb{1}_{(SRL_i)}$), indicators $\mathbb{1}_{(FY\_s)}$ for each fiscal year between 2010 and 2018, and their interactions:

$$\mathrm{P}(Renew_{it}) = \beta\,\mathrm{I}(SRL_i) + \sum_{j=2010}^{2018} \gamma_j \mathrm{I}(t=j) \times \mathrm{I}(SRL_i) + X_{it}'\delta + FE_{zip\times year} + \varepsilon_{it} \tag{4}$$

The model additionally includes control variables ($controls_{it}$), which account for characteristics of the home such as its elevation relative to the flood plain, the number of floors, whether it is a mobile home, the age of the home, the age of the policy, and the NFIP's rating of the actions that the community has taken to reduce its flood risk (see Table 3 and Table 14 for a description of each control variable).

Our preferred model estimates a linear probability model and includes individual fixed effects α_i, fiscal year (FY) fixed effects δ_s, and month (January, February, etc.) fixed effects μ_k to respectively capture unobserved characteristics of the individual policyholder or time of year that may affect households' renewal decisions. In alternative specifications of the model, we replace individual fixed effects with ZIP fixed effects and change the structure to capture time effects.

3.1.2 Estimation results

We estimate several specification of the renewal decision model (equation (4)), reported in Table 9. Column (3) describes the results of our preferred model, which allows comparisons at the individual level. Because the individual fixed effects in column (3) are often specified with only a few (2–3) observations, we present in column (2) and column (1) models that replace individual fixed effects with ZIP fixed effects as robustness checks. Column (2) and column (1) differ in how they capture time effects. The first specification (column 1) controls for time effects by including month fixed effects as well as a quadratic monthly time trend, in which the time variable takes values between 1 (for January 2010) and 108 (for December 2018). Column (2) modifies the model in column (1) by omitting the quadratic time trend and instead including year fixed effects. All

columns show standard errors, heteroscedasticity-robust and clustered by state, in parentheses.

Table 5: Regression results: Renewal decisions of the 2009 policy cohort between 2010 and 2018

	Dependent variable:		
	P(Renew)		
	(1)	(2)	(3)
I(t = 2010) x I(SRL)	0.004	−0.005	−0.01
	(0.01)	(0.01)	(0.01)
I(t = 2011) x I(SRL)	0.02	0.02	0.01
	(0.01)	(0.01)	(0.01)
I(t = 2013) x I(SRL)	−0.16***	−0.16***	−0.17***
	(0.02)	(0.02)	(0.02)
I(t = 2014) x I(SRL)	−0.17***	−0.17***	−0.18***
	(0.02)	(0.02)	(0.02)
I(t = 2015) x I(SRL)	0.03	0.04*	0.02
	(0.02)	(0.02)	(0.02)
I(t = 2016) x I(SRL)	0.01	0.03	0.01
	(0.02)	(0.02)	(0.02)
I(t = 2017) x I(SRL)	−0.03	−0.01	−0.02
	(0.02)	(0.03)	(0.03)
I(t = 2018) x I(SRL)	−0.04	−0.01	−0.04
	(0.03)	(0.03)	(0.03)
I(SRL)	−0.01	0.001	0.01
	(0.01)	(0.02)	(0.02)
Controls	No	Yes	Yes
ZIP FE	No	Yes	No
Year FE	Yes	Yes	No
ZIP x Year FE	No	No	Yes
Clustered SE	Policyholder	Policyholder	Policyholder
Observations	2,068,727	2,024,035	2,024,035
R^2	0.01	0.05	0.12
Adjusted R^2	0.01	0.04	0.06

Notes: Dependent variable is the renewal indicator variable. Fiscal year 2012 is the reference category. Standard errors, heteroscedasticity-robust and clustered by policyholder, are in parentheses.

The third row in column (3) shows the interaction between the SRL indicator (SRL) and policyholders' renewal decision in fiscal year 2013 (FY_13). It shows that SRL property owners reduced their renewal probability by 17 percentage points during this period. This decline is noteworthy because it occurs after the ratification but before the implementation of Biggert-Waters. It coincides with the first premium rate increase after the ratification of the reform. That rate increase

applied similarly to SRL and non-SRL properties (see Table 2), but we find that it affected their renewal decisions differently.

Similarly, the interaction between the SRL indicator (SRL) and the indicator (FY_14) captures the drop in renewal rates in the year immediately following the implementation of Biggert-Waters, when the treatment and control groups first experienced different premium ratings. In fiscal year 2014, SRL property owners reduced their renewal probability by 22 percentage points in response to the implementation of the reform. Overall, about one fourth of SRL property owners decided to stop insuring in response to the reform in the two years after its passage.[15]

Finally, the SRL interaction terms including the longer term indicators also show slightly smaller effects of the reform, around 5 and 11 percentage points respectively. This return to pre-event renewal probabilities can be explained by a selection issue: property owners that renew their policy despite the previous rate increases may be especially likely to renew despite future rate increases. The significance and sign of the longer term interaction terms are, however, inconsistent across the different specifications and so warrant some caution in interpretation. Otherwise, our results appear robust to different specifications of the model, as shown in columns (1) to (3).[16]

3.1.3 Event study regression with quarterly time effects

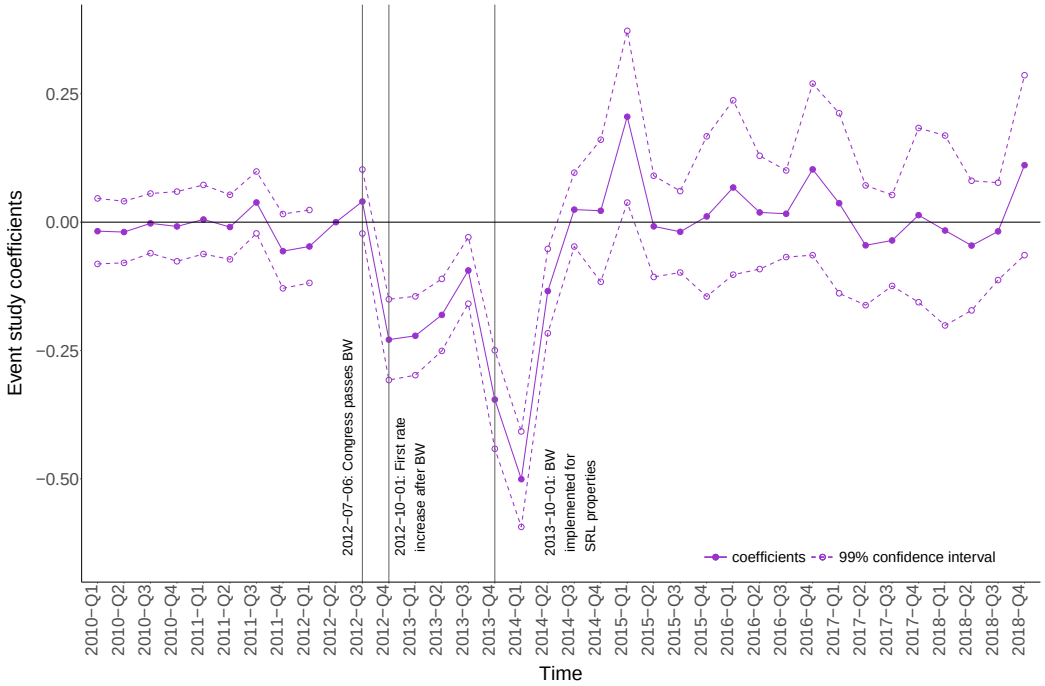
We complement the analysis in Table 9 with an event study approach that examines the effect of the reform on quarterly renewal rates for our entire sample period. We implement the event study by replacing the fiscal year dummies in equation 4 by quarter-year dummies. The 2012-Q2 dummy is the omitted category. Figure 4 plots the coefficients and 99% confidence intervals. Renewal rates are not statistically different for the nine quarters before the ratification of the reform. The event study model, thus, provides general support for the parallel trends assumptions. Figure 4 further shows that the reductions in renewal rates begin with the first rate increase after the ratification of the reform (2012-Q4) and persist until after the implementation of Biggert-Waters (2013-Q4). Starting 2013-Q3, renewal rates are no longer statistically different from pre-reform levels.[17]

[15] We calculate this 27% effect as follows. We assume that SRL properties would have renewed at the rate of non-SRL properties if not for the reform. Let p_{FY_13} and p_{FY_14} represent the renewal rates of non-SRL properties in fiscal year 2013 and fiscal year 2014, respectively. Also let bw_{FY_13} and bw_{FY_14} represent the estimated effect of Biggert-Waters on SRL properties in Column 3 of Table 9. Then, we calculate the total effect of the reform on SRL property renewals as a reduction of $p_{FY\_13} \cdot p_{FY\_14} - (p_{FY\_13} - bw_{FY\_13}) \cdot (p_{FY\_14} - bw_{FY\_14}) = 0.81 \cdot 0.77 - (0.81 - 0.17) \cdot (0.77 - 0.22) = 0.27$.

[16] We also estimate these regressions using the 2010 cohort, instead of the 2009 cohort, and find similar results (Table 15 in Appendix I).

[17] Figure 9 in Appendix H additionally plots the renewal rate calculated by dividing the number of policies that were renewed at time *t* by the number of policies that were in force one year before.

Figure 4: Renewal decisions between 2010 and 2018: Event study coefficients



Notes: Event study coefficients and 99% confidence intervals are plotted. The 2012-Q2 dummy is the reference category. Renewal rates are not statistically different for the nine quarters before the ratification of the reform. The figure further shows that the reductions in renewal rates begin with the first rate increase after the ratification of the reform (2012-Q4) and persist until after the implementation of Biggert-Waters (2013-Q4). Starting 2013-Q3, renewal rates are no longer statistically different from pre-reform levels.

3.1.4 Demographic Explanations

As a complement to the renewal analysis of Section 3.1.2 we aim to break down the impact of the reform on renewal rates into the effect of demographic variables. We restrict the sample to SRL properties and employ a linear probability model to examine whether policyholders, who are insured in fiscal year 2012, renew their policy in fiscal year 2015 in dependence of several explanatory factors. Table 6 shows the regression results. The results display a statistically significant but economically insignificant effect of the loading factor on SRL property owners' renewal rates in the two fiscal years after the ratification of the reform. On the ZIP code level, the table additionally finds no significant effect of demographic variables such as the gini coefficient, the mean income, the share of while people in the population, and the share of high school or bachelor degrees in the population. These findings indicate that adverse selection (see the coefficient of the loading factor) and liquidity constraints (see the coefficient of the income on ZIP code level) play only a minor role in explaining our findings.

Table 6: Regression results: Renewal decisions of the 2009 SRL policy cohort between fiscal year 2012 and fiscal year 2015

	Dependent variable:
	renewal_FY_12_FY_15
loading_factor	-0.002^{***}
	(0.001)
gini_coefficient	-0.402
	(0.457)
Income (ZIP code) / 10000	-0.001
	(0.009)
owner_occupied_pct	-0.050
	(0.230)
white_pct	-0.107
	(0.075)
high_school_pct	0.159
	(0.174)
bachelors_pct	0.034
	(0.295)
Intercept	0.491
	(0.311)
Clustered SE	State
Observations	1,113
R^2	0.004
Adjusted R^2	-0.002
Residual Std. Error	0.474 (df = 1105)

Notes: Dependent variable is the renewal indicator variable. The linear probability model analyzes whether SRL policyholders, who are insured in fiscal year 2012, renew their policy in fiscal year 2015 in dependence of explanatory variables. Standard errors, heteroscedasticity-robust and clustered by state, are in parentheses.

3.1.5 Loss history and mitigation status

Our end-line data, the SRL Property Database, may offer some insights on whether certain types of SRL property owners were less likely to renew. In fiscal year 2012, we are able to match 656 out of 1,154 SRL properties from the 2009 cohort in the policy level, panel data with the SRL Property Database using a unique property location indicator. For these properties, we compare policyhold-

ers who were uninsured in fiscal year 2015 – one year after the implementation of Biggert-Waters pricing – to those that continued to insure in fiscal year 2015.

We consider two possibilities. First, we examine whether SRL property owners who stopped insuring were more likely to have mitigated their flood risks than those who continued to insure. Mitigation is a partial substitute for insurance and so higher insurance costs might have encouraged some SRL property owners to adopt mitigation strategies. The SRL property database includes information on whether the properties were mitigated through home improvements such as elevation. It also indicates whether the risk was "mitigated" through relocation and destruction of the home. Table 7 compares the mitigation status of the SRL properties that were insured versus those that were uninsured. While we observe only small differences across most types of mitigation, elevation of the building may partly explain why some SRL properties decided not to renew – 17% of uninsured properties are elevated, versus 5% of insured properties. The majority of both uninsured and insured properties are, however, unmitigated (76% of uninsured properties, versus 92% of insured properties). Still, the marked difference in mitigation status raises the question whether mitigation can explain why SRL policyholders decided not to renew. We can do a back-of-the-envelope calculation to estimate an upper bound for the effect of mitigation on renewal decisions. Using the difference in mitigation status of uninsured and insured properties and that 27% of SRL property owners decided to stop insuring due to the reform, we conclude that at most 4% of SRL property stopped insuring due to mitigation serving as a substitute for insurance.[18] This is, however, a generous upper bound. First, mitigation does not serve as a full substitute for insurance in at least some cases. For example, the right-hand side of Table 7 shows that some mitigated properties still decided to insure. Second, the upper bound assumes that mitigation efforts took place in the two years after the reform while our data does not show the timing of mitigation but only the status as of May 2018.

Second, we examine whether a policyholder's loss experience affected her decision to renew. Previous research finds that consumers' flood experiences affect their decision to insure against flood (Browne and Hoyt, 2000; Michel-Kerjan and Kousky, 2010; Gallagher, 2014). We compare the insured and uninsured based on their claims history. The median claims payments and median total payments per property are slightly higher for insured properties than uninsured properties; however, these differences are not statistically significant due to the large standard deviations in these measures. In summary, the SRL properties that were no longer insured following Biggert-Waters do not appear different, in claims payments, than the SRL properties that continued to

[18] We calculate this 4% effect as follows. Employing the difference in mitigation status of uninsured and insured properties ($0.92 - 0.76$) and that 27% of SRL property owners decided to stop insuring in response to the reform in the two years after its passage, we calculate: $0.27 \cdot (0.92 - 0.76) = 0.04$.

Table 7: Statistics of SRL properties in fiscal year 2012 in dependence of their insurance status in fiscal year 2015

	Uninsured in FY 2015 (462)			Insured in FY 2015 (194)		
Claims Statistics (as of Oct. 2012)	Claims Payments	Tot. Payment	Tot. No. Losses	Claims Payments	Tot. Payment	Tot. No. Losses
Mean	47,374	219,633	6	48,385	231,343	7
St. Dev.	54,144	154,180	3	56,747	154,737	3
Pctl(1)	2,243	18,469	2	1,889	26,337	2
Pctl(25)	13,614	117,042	4	14,017	130,012	4
Median	30,725	190,621	6	30,253	207,695	6
Pctl(75)	59,035	284,488	7	60,669	291,172	8
Pctl(99)	277,069	801,688	18	314,954	713,883	21
Type of Mitigation (as of May 2018)						
Building acquired and demolished as part of a program			0.02			0.01
Building elevated to or above BFE			0.17			0.05
Building demolished but not acquired through a federal program			0.01			0.00
Building replaced by a new elevated/floodproofed building			0.04			0.02
Building protected by a flood control/stormwater management project			0.00			0.00
None			0.76			0.92

Notes: Claims and mitigation statistics of SRL properties in fiscal year (FY) 2012 are displayed. Properties that are insured in fiscal year 2015 are compared with properties that are uninsured in fiscal year 2015. Monetary amounts are converted into 2018 dollars.

insure after the reform.

3.2 Coverage choices

3.2.1 Empirical estimation and results

We also examine the effect of Biggert-Waters on coverage choices of SRL and non-SRL properties. Tracking a cohort over time creates a selected sample if property owners decide not to renew. Thus, home and policy characteristics at the beginning of our observation period can differ from those at the end of our observation period. We want to avoid this selection process and thus examine the coverage limit choices of policyholders who renewed each year between 2010 and 2018. This leads to a balanced panel with more than 700,000 policy-year observations.[19] The empirical test for the effect of Biggert-Waters on coverage choices is, with the exception of the dependent variable, identical to the regression model for the renewal decisions. The dependent variable is defined as ratio of building coverage and building coverage chosen in 2009:

$$coverageChoice_{it} := \frac{buildingCoverage_{it}}{buildingCoverage_{i,2009}}. \tag{5}$$

We again employ an event study approach to examine the effect of the reform on quarterly coverage choices for our entire sample period. We implement the event study by replacing the fiscal year dummies by quarter-year dummies. The 2012-Q2 dummy is the omitted category. Figure 5 plots the coefficients and 99% confidence intervals. Coverage choices are not statistically different for all quarters in our sample period.[20]

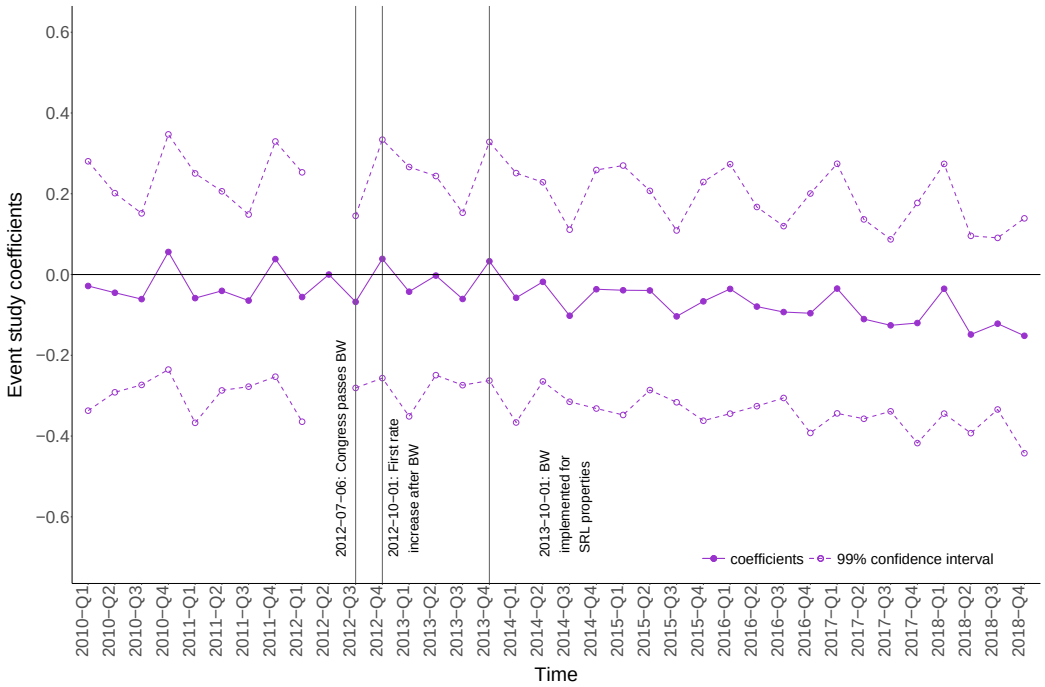
We additionally estimate the specifications of the regression model as we did in the previous section. The results indicate that the reform did not meaningfully affect SRL property owners' building coverage choices in the fiscal years 2013 and 2014.[21]

[19] As a robustness check we analyze the coverage limits of all policyholders in the 2009 cohort, including those that do not renew each year (see Table 18 in Appendix I).

[20] Figure 10 in Appendix H additionally plots the coverage choices calculated by dividing the chosen building coverage at time t by the building coverage chosen in 2009.

[21] Table 16 in Appendix I shows the regression results. Further, we examine (1) the coverage limits of the 2010 cohort instead of the 2009 cohort (Table 17) and (2) the coverage limits of all policyholders in the 2009 cohort, including those that do not renew (Table 18). Each set of analyses provides similar results to those presented here.

Figure 5: Coverage choices of the 2009 policy cohort renewing each year between 2010 and 2018: Event study coefficients



Notes: Event study coefficients and 99% confidence intervals are plotted. The 2012-Q2 dummy is the reference category. Coverage choices are not statistically different for all quarters in our sample period.

3.3 Adverse Selection

The canonical explanation for a lack of insurance demand even if the policies are subsidized on average is adverse selection. The idea is that the expected loss of the properties varies so strongly that even though the average property is subsidized, a subset of properties pays more than the actuarially fair price. This would give the property owners a reason not to renew their coverage after a price increase because the new price could lie above their willingness to pay for insurance, even if that magnitude was determined by a standard expected utility model.

A first test of this explanation is already reported in Table 6. If the loading factor, which we calculate with all available data, decreases the likelihood to renew, this would indicate that properties with lower expected cost and premiums closer to (or above) the actuarially fair price are more likely not to renew their flood insurance. However, while we do see a statistically significant effect of the loading factor in this analysis, it is very small in terms of absolute magnitude. 91% of SRL properties have a loading factor smaller than 1. The mean loading factor of SRL properties is below 0.5. Thus a reported coefficient of 0.002 makes the loading factor able to explain less than a fifth of a percentage point of the cancellations. While there might be statistical evidence of adverse selection, there is no economically significant effect.

While the loading factor analysis already indicates a minor role of adverse selection, it might be criticized due to the fact that we can only calculate the loading factor based on the information available to us and thus the insurance program. If there is considerable asymmetric information regarding the expected loss, adverse selection could still be a reasonable explanation for the observed renewal behavior. Einav et al. (2010) report a test statistic which does not suffer from this shortcoming, because it uses ex-post observations of the expected loss. They note that if adverse selection exists in a market, an increase in prices should lead to an increase in expected cost of the insured properties. The rationale is that adverse selection lets those property owners drop coverage which have the lowest expected cost. Thus, the properties remaining after a price increase should have higher expected costs, on average. This observation is independent of the question whether adverse selection is caused by asymmetric information or by incomplete pricing of the insurance program.

We examine the data for this pattern both descriptively and inductively. Table 8 shows the price and expected cost for all SRL properties insured in a given year. While the average price of the insurance coverage increases by 91% between 2012 and 2018, the expected cost remains almost constant, increasing by less than 4% over the same time period. This is a first indication that the results of the loading factor analysis are correct: while some adverse selection exists in the market,

the economic effects of the phenomenon are rather small.

Table 8: Average Expected Cost by Year for SRL Properties

Year	Price	Expected Cost
2012	6.8	48.5
2013	7.1	47.3
2014	8.1	49.0
2015	9.0	50.4
2016	10.3	50.6
2017	11.4	50.3
2018	13.0	50.3

Note: Expected cost is the expected payment per $1,000 of insurance coverage, in $2012.

For an inductive test for the pattern of increasing expected cost in prices, we estimate two multivariate models. The first is a difference-in-differences model that leverages the reform, which increased prices for SRL properties but does not affect non-SRL properties. This analysis considers whether the reform leads to a different development in the expected costs among the SRL properties than among the non-SRL properties. We estimate

$$cost_{it} = \beta_j \sum_{j=2013}^{2018} \mathrm{I}(t \geq j) \times \mathrm{I}(SRL) + \delta\, \mathrm{I}(SRL) + X'_{it}\gamma + \mathrm{FE}_{zip \times year} + \varepsilon_{it} \tag{6}$$

where $cost_{it}$ is the expected cost per $1,000 of coverage, and X'_{it} is a set of model controls described above. This and the model below only use observations from fiscal years 2012 to 2018. Thus, this estimation compares the program's expected costs in each year following the reform to its expected costs in 2012 and differentiates this comparison between SRL and non-SRL properties.

Table **??** shows the result of this estimation with year fixed effects and without control variables (column (1)) and with year x ZIP code fixed effects and control variables (column (2)). We see no statistically significant difference in the differences in expected costs for SRL and non-SRL properties in any of the years which were affected by the reform. Further, the coefficients are not even consistent in their sign, which should be positive if there was any evidence of adverse selection.

Equation (6) does not analyze the influence of price on expected costs directly, but rather uses the reform as a proxy for price increases. In a second model, we provide a more direct test of the influence of price on cost. To avoid possible endogeneity effects, we leverage the exogenous price

variation created by the reform as an instrument for the price. We estimate

$$cost_{it} = \beta \widehat{p_{it}} + \delta \mathrm{I}(SRL) + X_{it}'\gamma + \mathrm{FE}_{zip \times year} + \varepsilon_{it} \tag{7}$$

where the first stage is

$$p_{it} = \alpha_j \sum_{j=2013}^{2018} \mathrm{I}(t \geq j) \times \mathrm{I}(SRL) + \lambda \mathrm{I}(SRL) + X_{it}'\theta + \mathrm{FE}_{zip \times year} + \nu_{it}. \tag{8}$$

The results are given in columns (3) and (4) of Table **??**, where the former again reports the results with year fixed effects and without control variables and the latter reports those with year x ZIP code fixed effects and control variables. In both specifications the effect of price on expected costs is positive, but not statistically significant. All analyses of adverse selection as the cause for the observed renewal behavior of SRL property owners thus come to a consistent conclusion: while adverse selection may play a small role in the renewal behavior of SRL property owners after Biggert-Waters, the effect is not strong enough to explain the magnitude of our findings. This is in line with other analyses in the literature, including the study of health insurance decisions reported by Finkelstein et al. (2019).

[Note, which prob goes as a footnote in the affordability section: Households can escrow flood insurance payments. "You can pay your insurance premium with a credit card (American Express, Diners Club, Discover Card, Master Card or Visa) or with cash, check or money order. Your premium may be paid through an escrow account established by your mortgage lender, at your lender's discretion. If your lender requires you to buy flood insurance and escrows for other types of insurance or taxes, they are required to also escrow flood insurance premium payments. Your payment for coverage is due to your agent with your application."]

Table 9: Regression results: Renewal decisions of the 2009 policy cohort between 2010 and 2018

	Dependent variable:	
	P(Renew)	
	(1)	(2)
I(t = 2010) x I(SRL)	−0.02	−0.05
	(0.03)	(0.03)
I(t = 2011) x I(SRL)	−0.001	0.01
	(0.03)	(0.04)
I(t = 2013) x I(SRL)	−0.21***	−0.14***
	(0.03)	(0.05)
I(t = 2014) x I(SRL)	−0.14***	−0.14**
	(0.04)	(0.06)
I(t = 2015) x I(SRL)	0.02	−0.001
	(0.04)	(0.06)
I(t = 2016) x I(SRL)	0.01	0.08
	(0.04)	(0.05)
I(t = 2017) x I(SRL)	−0.02	−0.01
	(0.04)	(0.06)
I(t = 2018) x I(SRL)	−0.07	−0.04
	(0.05)	(0.06)
I(SRL)	0.04	0.07
	(0.05)	(0.05)
State	LA	TX
Controls	Yes	Yes
ZIP x Year FE	Yes	Yes
Clustered SE	Policyholder	Policyholder
Observations	175,786	136,824
R^2	0.08	0.12
Adjusted R^2	0.06	0.07

Notes: Dependent variable is the renewal indicator variable. Fiscal year 2012 is the reference category. Standard errors, heteroscedasticity-robust and clustered by policyholder, are in parentheses.

3.4 Media

Table 10: Media Count by Outlet, Top 15

Rank	Outlet	Articles
1	insurancejournal.com	44
2	tampabay.com	26
3	americanactionforum.org	16
4	nytimes.com	10
5	propertycasualty360.com	9
6	theconversation.com	8
7	houstonchronicle.com	7
8	propublica.org	7
9	artemis.bm	6
10	govtech.com	6
11	grist.org	6
12	nbcnews.com	6
13	americanprogress.org	5
14	app.com	5
15	dsnews.com	5

Note:

$$\text{P}(Renewal_{it}) = \beta Media_{t-1} + FE_{zip} + \varepsilon_{it}$$

$$\text{Coverage Limit Ratio}_{it} = \text{Coverage Limit}_{it} / \text{Coverage Limit}_{i,2010}$$

Table 11: Regressions

	Dependent variable:		
	P(Renewal)		
	(1)	(2)	(3)
Media Count$_{t-2}$	-0.024^{***}	-0.024^{***}	
	(0.003)	(0.003)	
Media Count$_{t-1}$	-0.021^{***}	-0.018^{***}	
	(0.003)	(0.004)	
Media Count$_{t}$	-0.013^{***}	-0.010^{***}	
	(0.003)	(0.003)	
Media Count$_{t+1}$		-0.003	
		(0.003)	
Media Count$_{t+2}$		-0.006^{**}	
		(0.003)	
I(Media Count$_t \in (1, 2]$)			-0.089^{***}
			(0.019)
I(Media Count$_t \in (2, 4]$)			-0.164^{***}
			(0.017)
I(Media Count$_t \in (4, 16]$)			-0.335^{***}
			(0.028)
ZIP FEs	Yes	Yes	Yes
Clustered SEs	ZIP	ZIP	ZIP
R2 (Within)	0.102	0.104	0.068
Observations	5,673	5,661	5,673

Note: Add note.

Table 12: Regressions

	Dependent variable:		
	P(Renewal)		
	(1)	(2)	(3)
I(Media Count$_{t-1} \in (1, 2]$)	-0.114^{***}		
	(0.020)		
I(Media Count$_{t-1} \in (2, 4]$)	-0.139^{***}		
	(0.015)		
I(Media Count$_{t-1} \in (4, 16]$)	-0.400^{***}		
	(0.026)		
Media Count$_{t-3}$		-0.013^{***}	-0.012^{***}
		(0.003)	(0.004)
Media Count$_{t-2}$		-0.020^{***}	-0.017^{***}
		(0.004)	(0.004)
Media Count$_{t-1}$		-0.026^{***}	-0.018^{***}
		(0.003)	(0.004)
Media Count$_{t}$			-0.005
			(0.004)
Media Count$_{t+1}$			-0.005
			(0.003)
Media Count$_{t+2}$			-0.004
			(0.003)
Media Count$_{t+3}$			-0.002
			(0.003)
ZIP FEs	Yes	Yes	Yes
Clustered SEs	ZIP	ZIP	ZIP
R2 (Within)	0.077	0.101	0.108
Observations	5,673	5,673	5,642

Note: Add note.

4 Institutional Explanations

In this section, we review several additional potential institutional explanations for our findings. Of particular interest is how to explain the finding that SRL properties renewed their insurance policies at lower rates than non-SRL properties in the interim between when Biggert-Waters was passed and when it was implemented.

Home value declines.

- Previous research shows that premium subsidies are capitalized into the value of insured property (CITE). Browne JRI maybe
- Perhaps the passage of the reform reduced the market value of SRL properties, and households responded by dropping their policies.
- Response: when houses decline in value, consumers appear to hold on to their insurance and hope for a loss. Carson et al. find that arson rates increase when housing values go down.
- Make the point that ppl can get cash rather than rebuild the home

Private market.

- Suppose households with increasing rates left the NFIp bought insurance on the private market.
- Private market accounts for about 5% of residential flood insurance in the U.S.
- Private models better than public models – paper by Joyce Lin in the JRU(?)
- Private insurers should not be able to offer sustainably rates below the actuarially fair rate. Private insurers would likely need to misestimate the risk to offer these properties lower rates.

Mortgage requirements.

- Non-SRL properties would have declined but have mortgages. Note that SRLs and nonSRLs are about the same age in the data.

- Why are ppl dropping only in 2012?
- I believe that people who move typically cancel their policies. Can we observe cancellations? If so, it might help indicate whether SRL owners stay in their properties longer.

Rebuilding plan.

- Maybe SRL properties stop insuring because they relocate after experiencing a claim.
- Todo: Look at claims. Does nonrenewal coincide with claims?
- Seems like relocations would be cancelled policies so that we could possibly observe the cancellation date.

5 Discussion

Our empirical analysis provides two main results. First, we see a relative increase in policy cancellations by SRL properties compared to non-SRL properties after Biggert-Waters takes effect and the premiums on SRL properties increase. Second, we already see this increase in policy cancellations one year earlier, after the first increase of premiums after Biggert-Waters was ratified, but before it took effect. Here, policyholders with SRL properties cancel their insurance coverage significantly more often than policyholders with non-SRL properties, even though the premium increase for both types of properties was the same. In the following, we will discuss both of these results in turn.

5.1 Responses to the Reform, October 2013

The motivating premise of the Biggert-Waters policy initiative was, in part, that policyholders would not cancel their insurance coverage as long as it is priced better than actuarially fair for them. Moreover, the NFIP directly communicated the reform to policyholders in the renewal letter "your premium must increase each year until it reaches the full-risk rate" (Section 2.2).

Our results show that this premise was not true. After the reform increased premiums for SRL property holders, they canceled their policies. The premise could be based on the predictions of a standard expected utility model, and so policyholders' responses suggest some deviation from the standard modeling assumptions.

One explanation for the behavior of policyholders could thus be that they systematically underestimate their own risk of a flood. The role of subjective probabilities in insurance demand is well documented in studies of both experimental and naturally occurring data (e.g., Bajtelsmit et al., 2015; Gallagher, 2014) and the misrepresentation of probabilities in the decision-making process has often been used to explain behavior divergent from canonical theory (Barseghyan et al., 2013; Sydnor, 2010). However, most results in this literature point in the direction of subjective probabilities which are larger than objective ones. Evidence in Barseghyan et al. (2013), for example, suggests that this is the case in car insurance and homeowners insurance demand. Our results can nevertheless be reconciled with this previous literature because we consider insurance against a risk that is substantially different in nature from those that have been studied previously. Since different risks can lead to different subjective probabilities (Slovic, 1987), it is entirely possible that flood risk is underestimated in comparison to the risk insured by homeowners contracts. This view is also supported by Browne et al. (2015) who show that policyholders who are willing to pay high markups for protection against bicycle theft are, at the same time, unwilling to pay for actuarially fair flood insurance coverage.

A possible objection to the explanation based on subjective probabilities is that policyholders seem to learn about their exposure from previous losses, a fact that is shown for flood insurance explicitly by Gallagher (2014). Such learning should be particularly strong for owners of SRL properties as they, by definition, have experienced multiple losses in the past. A separate mechanism, however, could be counteracting this experience learning effect. Laury and McInnes (2003) document that policyholders also learn about their risk from the premiums they have to pay for covering that risk. Since loss experiences were accompanied by premium increases before, the policyholders might have estimated their loss exposure to be accurately reflected by the premium they paid before Biggert-Waters took effect. Any increase in the premium due to the reform (rather than due to experienced losses) would then be interpreted as an increase above actuarially fair levels.

5.2 Responses to the *Anticipated* Reform, October 2012

While an explanation of our first result by subjective expected utility theory thus seems possible and coherent, explaining the second result with canonical theory is difficult. Since both SRL properties and non SRL properties experience the same rate increase in October of 2012, the differential reaction to the price increase by both types of policyholders is puzzling. We will cover some possible explanations here and discuss their validity.

Recent theoretical research proposes that liquidity constraints may importantly influence consumers' insurance choices (Ericson and Sydnor, 2018; Rampini and Viswanathan, 2019) and empirical evidence for this has been shown in the development context (Casaburi and Willis, 2018). Liquidity constraints appear if consumers are unable to pay insurance premiums that exceed a certain amount. This highlights the role of the absolute insurance premium payment rather than the relative rate paid by the policyholders. As can be seen from Table 3, SRL property owners, on average, pay a larger absolute premium than non SRL property owners. Thus, even a synchronous relative premium increase such as the one in October 2012 impacted the absolute premiums in both policyholder groups differently. If a binding absolute liquidity constraint existed, it could have been the reason for the sudden increase in cancellation rates by the SRL property owners. However, there are two arguments against this explanation. For one, we see no such asynchronous renewal behavior by policyholders for any of the three premium increases (May 2010, October 2010 and October 2011) before the ratification of Biggert-Waters. Secondly, such binding liquidity constraints are more likely to appear for poorer households than for richer ones. Yet, when including property value as an explanatory variable for the renewal rate, we see no significant coefficient on the interaction with the October 2012 to October 2013 time period.

Two alternative explanations of the early spike in cancellations by SRL properties are related to behavioral models. On the one hand, policyholders could have misunderstood the policy. Because Biggert-Waters was signed into law before the October 2012 premium increase, SRL property owners might have falsely attributed the increase to the reform. In this case, the above mentioned mechanisms due to an asynchronous premium increase might have applied to part of the population explaining asymmetric behavior by the two types of policyholders in 2012. On the other hand, policyholders might have decided based on a falsely perceived uncertainty in their contracts. Policyholders might have realized that their current rate is still favorable to them but thought that, according to the mechanisms detailed above, they will have to pay an unfavorable premium soon. Out of fear of potentially being locked into such an unfavorable rate, they canceled their insurance contract immediately and thus the cancellation rates of SRL properties increased earlier than October 2013.

Both effects require that at least part of the SRL property owners were aware of the Biggert-Waters reform prior to receiving the policyholder information letter from their insurer. We surveyed both media outlets for mentions of Biggert-Waters and Google searches for increased interest in the reform before October 2012. While little coverage could be found in national media outlets such as the *New York Times*, ... The data on Google searches support the assumption that some policyholders were interested in the reform prior to it being in effect. ~~While the relative search~~

~~frequency was not as high as in October 2013, t~~ The year between October 2012 and October 2013 showed active searches for the reform, which increased around implementation in October 2013, with the SRL property prone states of Louisiana, Texas and Florida being among ~~the top seven~~ states with the most searches (Online Appendix D).

6 Conclusion

Public insurance programs are targeted at increasing the financial resilience of the population and, often, contain aspects particularly targeted at protecting vulnerable groups. This protection is usually achieved through premium subsidies (Jaspersen and Richter, 2015). Such premium subsidies can, however, threaten the financial sustainability of the insurance program. The extent of subsidization is thus a commonly discussed policy topic. Arguments against strong subsidization include that rational consumers should purchase subsidized insurance policies no matter how extensive the subsidy is (Schlesinger, 2013). This claim is tested empirically here.

We study the insurance decisions of an especially vulnerable group in the NFIP, SRL property owners. The Biggert-Waters Flood Insurance Reform Act increased the premiums of SRL property owners, and we assess how these rate increases affected their renewal decisions and coverage limit choices. Although SRL properties are still heavily subsidized, Biggert-Waters induced about one fourth of SRL property owners to stop insuring. It had a much smaller effect on coverage limit choices both in the short-run and in the long-run, affecting each by at most 6 percentage points. Our results are thus in contrast with canonical insurance demand models. Individuals cancel their policies in light of premium increases even if they are still heavily subsidized. Moreover, we observe differential responses to price increases between SRL and non-SRL property owners even before they received differential price increases. The ratification of the Biggert-Waters Act affected insurance choices even before its price increases were implemented. Our results are thus in line with other recent observations on insurance purchasing behavior in that they are hard to reconcile with canonical or even most common behavioral decision theories (Bhargava et al., 2017; Brot-Goldberg et al., 2017; Jaspersen et al., 2019).

While certain institutional effects might possibly explain our results, we find little evidence for them in our data. SRL property owners could, for example, have taken advantage of buyback programs or subsidized mitigation measures and thus rendered insurance coverage either unnecessary or too expensive to maintain. However, renewing and non-renewing SRL properties look virtually identical at the end of our observation period. It thus seems more likely that behavioral aspects in the decision process of individuals explain our results. As an alternative explanation,

individuals might have misunderstood the Biggert-Waters Act and thought that their insurance policy was immediately priced above actuarially fair rates after the law was passed. Inaccurate media coverage or peer effects could have potentially exaggerated this effect. Ultimately our analysis is unable to identify the causes of our observations. Doing so is an important direction of further research hopefully allowing the design of effective insurance reforms, both here and in other settings.

From the perspective of the policymaker it remains unclear whether Biggert-Waters attained its goals. While the premium rate increases contribute to a more financially sustainable NFIP, the tendency of SRL property owners to drop their insurance is a policy concern. When these homes flood again, the financial burden on the household will be greater, as will the federal recovery assistance needed. As stated above the loss of insurance coverage apparently did not lead property owners to adopt alternative risk management measures. In 2018, five years after the reform, 73% of SRL properties were unmitigated, 42% of existing SRL properties uninsured, and 36% of SRL properties both unmitigated and uninsured.

Our findings do not suggest easy policy solutions for insuring vulnerable groups, especially in our setting since flood risks are increasing. They do provide a warning that rate increases may have unintended consequences. Because the federal government pays a portion of uninsured losses through relief, it is not obvious that the reform reduced total public expenditures on these properties. One potential direction for future reforms is to pair premium subsidy reductions with mitigation grants (or loans). However, the effectiveness of such a future reform depends on households' willingness to mitigate. Mitigation decisions are not well understood and so are also an important topic for future research.

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Appendix A Re-underwriting of SRL properties

Figure 6: Letter sent to agents regarding re-underwriting SRL properties starting October 2012

U.S. Department of Homeland Security
500 C Street, SW
Washington, DC 20472

FEMA

W-12037

June 12, 2012

MEMORANDUM FOR: Write Your Own (WYO) Principal Coordinators and the National Flood Insurance Program (NFIP) Servicing Agent

FROM: Jhun de la Cruz
Chief, Underwriting Branch
Risk Insurance Division

SUBJECT: Re-Underwriting of Severe Repetitive Loss Policies at the NFIP Special Direct Facility

Please be advised that effective immediately, all Severe Repetitive Loss (SRL) policies that have been transferred to the NFIP Special Direct Facility and will renew on or after October 1, 2012, must be re-underwritten before they can be renewed.

Prior to policy renewal, the NFIP Special Direct Facility will require a new application, photos of the front and rear of the building, Elevation Certificate if applicable, and any additional supporting documents to ensure that policy information and rates are current and correct. Policies will be processed and issued based upon current rates, zone, and map information, except for those properties meeting the NFIP grandfathering eligibility rules.

SRL policies are high profile and are targeted by FEMA for mitigation under various grants programs. FEMA has found that the majority of existing SRL policies were originally written many years ago through various WYO Companies, and many of these policies were renewed year after year using the same rating information provided on the original flood application. Over time, in many cases, changes to the insured structures have been made, such as additions, modifications, and/or other structural improvements, but never reported to the NFIP. Since FEMA has never imposed a requirement for renewal recertification of the building description and other policy rating information, many SRL policies may be misrated.

Re-underwriting these policies and charging appropriate rates will enhance the fiscal soundness of the NFIP. Additionally, it will allow for better analysis when targeting risk for ongoing mitigation efforts, as well as ensure no delays in loss settlement due to rating discrepancies discovered at the time of loss.

Notes: The figure displays the letter sent to agents on 12 June 2012 to advise them of re-underwriting of SRL properties starting 1 October 2012.

Appendix B Renewal letter sent to for SRL property owners

Figure 7: Renewal letter sent to SRL properties starting August 2013

NATIONAL FLOOD INSURANCE PROGRAM
LETTER REGARDING YOUR POLICY RENEWAL

<Date>
<Named Insured> Policy # < >
Mailing Address: < > Property Address: < >

IMPORTANT — PREMIUM INCREASES FOR CERTAIN PRE-FIRM SEVERE REPETITIVE LOSS PROPERTIES

Dear Policyholder,

Subsidized flood insurance rates traditionally have been available for structures built before the effective date of a community's initial FEMA Flood Insurance Rate Map. The subsidized rates do not reflect the full risk of flood loss. Recent legislation, the Biggert-Waters Flood Insurance Reform Act of 2012, phases out subsidized rates for certain properties, including Severe Repetitive Loss (SRL) properties. Our records indicate that your building is an SRL property*, and you have been paying a subsidized rate.

Starting October 1, 2013, the subsidy you have been paying will be phased out as required by the law, and therefore, your premium must increase 25 percent each year until it reaches the full-risk rate. The enclosed renewal bill reflects the statutorily-required 25 percent increase.

To calculate your building's full-risk rate, your agent will need an Elevation Certificate. If the full-risk rate is less than the 25 percent increase, your premium will only increase to the full-risk rate.

Obtaining an Elevation Certificate will help you understand the extent of your flood risk; aid in making effective decisions to prevent or minimize your flood risk, such as elevating your home; and allow your agent to advise you about the most cost-effective approach to your flood insurance. ***If you don't have an Elevation Certificate for your building, you may need to hire a surveyor to come to your property to complete the certificate.*** Go to www.fema.gov/library/viewRecord.do?id=7408 for more information about obtaining an Elevation Certificate.

Now, more than ever, it is important that you know your true flood risk as flood insurance premiums shift to reflect that risk.

Please contact your insurance agent for more information.

***** a Severe Repetitive Loss property is defined as one that has at least four claim payments of more than $5,000 each, or a property in which at least two separate claims have been made where the cumulative amount of the claims exceeds the market value of the building within any ten-year period.

Notes: The figure displays the letter sent to SRL property owners 45 days before policy expiration to inform them about future rate increases.

Appendix C Media Coverage of Biggert-Waters and SRL Properties

We conducted a Google News search and a library search using the database of a major US university for media coverage of Biggert-Waters. We used the date range 1 January 2011 to 31 March 2014 and search terms "Flood Insurance Reform Act," "Biggert-Waters", "Biggert" and "Waters"', "NFIP Reform", and "repetitive loss". In case these search tools overlooked publications in important relevant outlets, we also searched these terms in the databases of *The New York Times*, *The Wall Street Journal*, *The Washington Post*, *The Houston Chronicle*, and *The New Orleans Advocate/The Times-Picayune*. This appendix includes a series of illustrative examples of media coverage of the Biggert-Waters reform. These are ordered chronologically.

Some of the first articles focused on the passage of Biggert-Waters, which was a component of a larger transportation bill as of 2 July 2012. Sen. Carl Levin of MI wrote an opinion column on the bill that several national newspapers such as *The Houston Chronicle* published.

- 2 July 2012, *The Houston Chronicle*, Carl Levin "Progress for students, transportation and homeowners"
  URL: chron.com/columns/article/GUEST-COLUMN-Progress-for-students-14141284.php

  > On the third important issue, the bill will provide some much needed equity to Michigan and other states through a five-year reauthorization of the National Flood Insurance Program. Michigan residents have paid over six times more in premiums than they have received in payouts from the National Flood Insurance Program. We must correct this disparity, and the bill we passed takes some steps to do so in requiring premiums that reflect the true risk of flooding. The conference report will end subsidies for "repetitive loss properties" that continue to be rebuilt in high risk areas.

- 2 July 2012, *The Times-Picayune*, The Times-Picayune Editorial Board, "Congress finally gave flood insurance program much needed stability: An editorial"
  URL: nola.com/opinions/article_9db6bda1-077a-524d-a90b-522beaecd2eb.html

  > The legislation passed Friday also was designed to make the program more reflective of the actual cost of insurance – and reduce its drain on the Treasury. Second homes, properties with repetitive losses and commercial properties must be charged actuarially sound rates. The rates will be phased in over five years in 20 percent increments by calculating the difference between the current rate and actuarial rates.

The insurance industry outlet *Insurance Journal* summarized Biggert-Waters and its implications for SRL properties after the reform's passage.

- 31 July 2012, *Insurance Journal*, Lori Widmer, "What to Know About the New Flood Insurance Program"
  URL: insurancejournal.com/news/national/2012/07/31/257

> What's different about Biggert-Waters is, well, everything. Instead of keeping the NFIP as status quo, there are now plenty of fundamental changes – modernizations to the 44-year-old program. To be phased out are subsidies on properties with repetitive losses, which many properties were afforded.

As of September 2012, *The Times-Picayune* reported uncertainty regarding how Biggert-Waters would be implemented.

- 5 Sept 2012, *The Times-Picayune*, Rebecca Mowbray, "Hurricane Isaac will introduce many New Orleans homeowners to wind deductibles"
  URL: nola.com/news/weather/article_8d9b5d76-33d9-582d-99e3-5960205e9e19.html

  > When Congress passed legislation in June that re-authorized the flood program for five years, it did so with a mandate for FEMA to make the program more actuarily sound. FEMA is still working on plans to translate that legislation into action, but it could result in higher rates for repetitive loss properties."

In summer 2013, a series of articles emerged in national (and local) outlets describing Biggert-Waters. Some of these described Biggert-Waters and repetitive losses in detail. Others were more general, reporting expected rate increases in stark terms.

- 28 July 2013, *The New York Times*, Jenny Anderson, "Outrage as Homeowners Prepare for Substantially Higher Flood Insurance Rates"
  URL: nytimes.com/2013/07/29/nyregion/overhaul-and-a-hurricane-have-flood-insurance-rates-set-for-h
  html?pagewanted=all

  > For the last seven years, Palmer Doyle, a retired firefighter, has paid between $350 and $458 annually for federal flood insurance...Now, though, the costs for Mr. Doyle are about to jump to as much as $15,000 annually over the next decade.

- 12 Aug 2013, *The Wall Street Journal*, Siobhan Hughes, "Flood Insurance Prices Surge"
  URL: wsj.com/articles/flood-insurance-prices-surge-1376350640?mod=searchresults&page=
  1&pos=8&tesla=y

  > Mr. Bubrig estimated that flood-insurance premiums on his home will increase from $633 to $28,000 a year, with a big chunk of the increase hitting as early as 2014.

- 28 August 2013, *The New York Times*, Nicholas Pinter, "The New Flood Insurance Disaster"
  URL: nytimes.com/2013/08/29/opinion/the-new-flood-insurance-disaster.html?searchResultPosition=
  8

  > The National Flood Insurance Reform Act of 2012 phases out subsidies for businesses, vacation homes and structures that flood repeatedly that already existed when the original program began. This means that rates for those policies will rise, some by tenfold or more.

Coverage of the law appears most concentrated around the weeks of its 1 October 2013 implementation.

- 4 September 2013, *Tampa Bay Times*, John Romano, "Rising flood insurance rates bearing down like a hurricane on Florida"
  URL: tampabay.com/news/business/realestate/rising-flood-insurance-rates-bearing-down-like-a-hurrica
  2140008/

  > If you're not familiar with Biggert-Waters, this is the short explanation: For decades, the federal government offered subsidized flood insurance in low-lying or coastal areas. In other words, the price paid was not equal to the risk involved...A typical high-risk home in Pinellas will see its premium go up 20 percent annually until it reaches an actuarially sound rate. So a waterfront home paying $2,000 for flood insurance will be paying nearly $5,000 in five years.

- 12 Oct 2013, *The New York Times*, Lizette Alvarez and Campbell Robertson, "Cost of Flood Insurance Rises, Along With Worries"
  URL: nytimes.com/2013/10/13/us/cost-of-flood-insurance-rises-along-with-worries.html?
  searchResultPosition=10

  > The law, officially known as the Biggert-Waters Flood Insurance Reform Act, is being rolled out in stages, with a major part having gone into effect on Oct 1. It removes subsidies that keep federal flood insurance premiums artificially low for more than a million policy holders around the country — a discount that was applied to properties that existed before the drawing of flood insurance rate maps. An estimated 20 percent of the property owners with federal flood insurance received these subsidies as the new law went into effect, and their premiums will rise, in some cases precipitously, either now, over the next several years or whenever they sell their properties...About 600,000 homeowners nationwide will see their rates rise only if they buy new policies or allow their current policies to lapse. Homeowners are now concerned that they may not be able to sell their homes because anyone buying a property will be forced to pay the steep premiums. This has created a worrisome ripple effect in the real estate market, and some residents fear that the value of their homes has dropped.

- 20 October 2013, *The Times-Picayune*, Lauren McGaughy, "Flood insurance, Common Core and congressional races: Capitol Digest for Friday, Oct. 18, 2013"

  > State Sen. Dan "Blade" Morrish, R-Jennings, has requested a joint legislative meeting to discuss imminent increases for Louisianians covered under the federal flood insurance program. The meeting, to be held in Baton Rouge on Wednesday, Oct. 23, will discuss recent changes approved by Congress to the National Flood Insurance Program. The changes, nestled in the Biggert-Waters Flood Insurance Reform Act of 2012, authorize phased-in increases in flood insurance premiums and the elimination of federal subsidies for residents in high-risk areas.

- 6 Nov 2013, *The Houston Chronicle*, Jim Sheehan, "Valuing riverfront property"
  URL chron.com/opinion/article/Valuing-riverfront-property-4961217.php

  > We found a great house...We made an offer, and she accepted it. But we won't be moving in...The insurance price we received in late September (from the National Flood Insurance Program) blew us away..In 2012, Congress passed and the President signed the Biggert-Waters Act, designed to address problems with the flood insurance program after hurricanes and floods gave the flood insurance trust fund a $25 billion hole. With the act, owners would no longer be able to build palatial second homes on coastal sand dunes secure in the knowledge that taxpayers would pick up the tab after a storm surge. Existing primary homeowners (who owned their homes before July 10, 2012) were assured that premium increases would be limited to 25 percent per year starting Oct. 1, 2013, if they had insurance before the act. New owners who purchased after July 10, 2012. would pay a much higher premium.

- 1 December 2013, *The Wall Street Journal*, "Flooding Taxpayers Again"
  URL wsj.com/articles/flooding-taxpayers-again-1385941343?mod=searchresults&page=1&pos=3&tesla=y

  > Thanks to the bipartisan Biggert-Waters reform signed by President Obama in July 2012, the federal insurer is slowly raising its rates to actuarially sound levels...That's been a shock to the affluent beachcombers who are accustomed to artificially cheap insurance. Businesses, vacation homes and homes with "repetitive" flood losses will see rates rise 25% a year until those "rates reflect true risk," according to the Federal Emergency Management Agency (FEMA), which administers the federal insurance program.

Finally, in early March 2014, media coverage of Biggert-Waters increased again due to the development and passage of the Homeowners Flood Insurance Affordability Act, which was signed into law 21 March 2014.

- 13 March 2014, *The Wall Street Journal*, Siobhan Hughes, "Senate Clears Flood-Insurance Legislation"
  URL wsj.com/articles/senate-clears-flood-insurance-legislation-1394749414?mod=searchresults&page=1&pos=2&tesla=y

  > The U.S. Senate on Thursday cleared flood-insurance legislation that would roll back rate increases that passed Congress less than two years ago, dealing a blow to fiscal conservatives but handing a victory to homeowners in flood zones...Property owners said they couldn't afford the premiums, and real-estate agents said that homes had become unsalable, since discounts and subsidies used by more than a million homeowners would expire upon the sale of the home.

- 17 March 2014, *The Houston Chronicle*, Press Release from Bay Area Houston Economic Partnership, "BAHEP and national flood insurance coalition score major victory in Congress"

URL chron.com/neighborhood/bayarea/news/article/BAHEP-and-national-flood-insurance-coalition-96
php

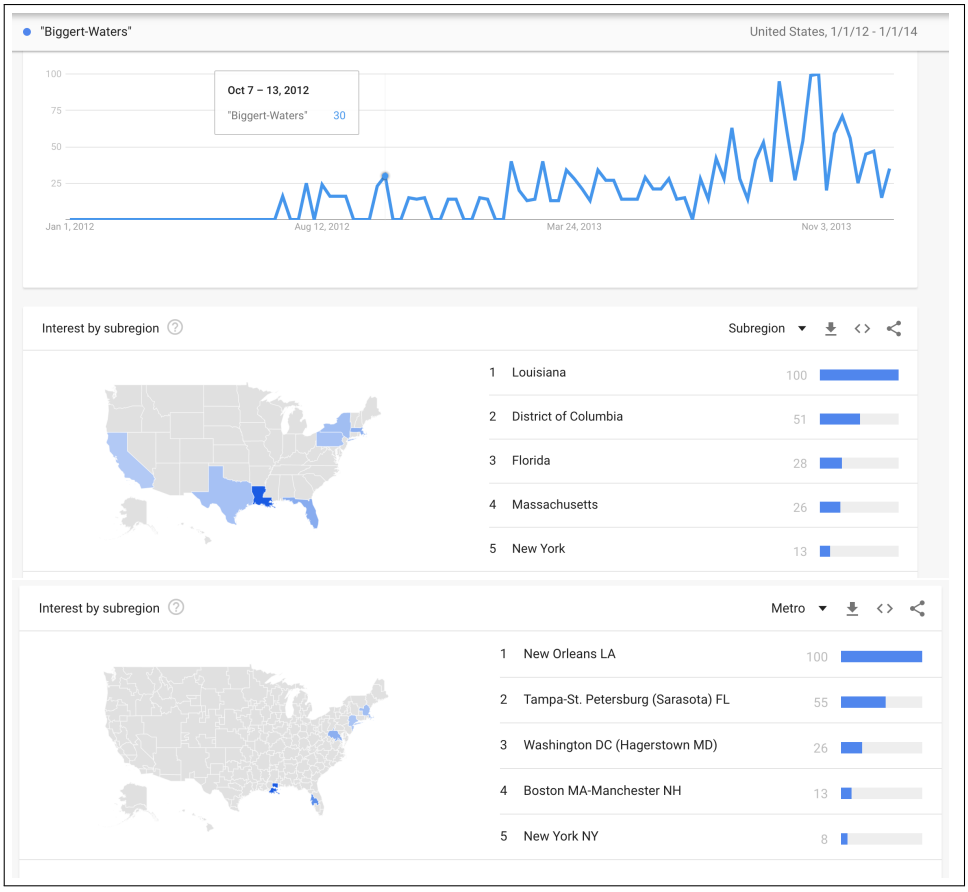
> Late in the day on March 13, 2014, the Senate passed House Bill 3370, the Homeowner Flood Insurance Affordability Act of 2014...This legislation significantly changes the Biggert-Waters flood insurance law by addressing a number of unintended consequences stemming from the legislation...[It] caps the maximum annual premium increase at 18 percent of the prior year's premium for all properties not subject to the higher 25 percent increase for second homes, commercial properties and severe repetitive loss properties.

Appendix D Google Trends for "Biggert-Waters"

We also searched Google Trends to examine how interest in the reform varied across time and location. Figure 8 provides the results for "Biggert-Waters," showing a local maximum, about 30 searches, around the time of the October 2012 rate increase that was unrelated to Biggert-Waters. Searches for Biggert-Waters peaked in October 2013, the month the law was implemented at about 100 searches. Two peaks occurred that month: one at the beginning of the month when prices increased, the second at the end of the month, which coincides with a new set of households' renewal choices as well as Hurricane Sandy. The maps show where the searches occurred; New Orleans and Tampa-St. Petersburg were the most common locations. Thus, the figure shows that searches for Biggert-Waters coincided both by timing of renewal declines observed in the data and the locations of many SRL properties.

We examined several other terms. "Flood insurance reform" also peaks, at about 100 searches, during the implementation of Biggert-Waters, but Google does not report the location of the searches because the search does not "have enough data." The following terms did not have enough searches to yield any results during the period of interest: "Flood Insurance Reform Act," "NFIP reform," "repetitive loss," and " 'Biggert' and 'Waters'."

Figure 8: Google Trends for "Biggert-Waters"



Notes: Figure shows results from a Google Trends search for "Biggert-Waters."

Appendix E Additional information on building rates

Table 13: Building rates in dependence of different basement options

September 2013	**SRL properties**		**Non-SRL properties**	
	$r_b^{(b)}$	$r_a^{(b)}$	$r_b^{(b)}$	$r_a^{(b)}$
No Basement	0.0076	0.0077	0.0076	0.0077
With Basement	0.0081	0.0114	0.0081	0.0114
With Enclosure	0.0081	0.0137	0.0081	0.0137
Elevated on Crawlspace	0.0076	0.0077	0.0076	0.0077
Non-Elevated with Subgrade Crawlspace	0.0076	0.0077	0.0076	0.0077
Manufactured (Mobile) Home	0.0076	0.0077	0.0076	0.0077
October 2013	**SRL properties**		**Non-SRL properties**	
	$r_b^{(b)}$	$r_a^{(b)}$	$r_b^{(b)}$	$r_a^{(b)}$
No Basement	0.0091	0.0092	0.0091	0.0077
With Basement	0.0097	0.0136	0.0097	0.0114
With Enclosure	0.0097	0.0163	0.0097	0.0137
Elevated on Crawlspace	0.0091	0.0092	0.0091	0.0077
Non-Elevated with Subgrade Crawlspace	0.0091	0.0092	0.0091	0.0077
Manufactured (Mobile) Home	0.0091	0.0092	0.0091	0.0077

Notes: The table displays the rate $r_b^{(b)}$ for basic building coverage until \$60,000 and the rate $r_a^{(b)}$ for additional building coverage above \$60,000 in the Restricted Sample for both SRL and non-SRL properties before (in September 2013) and after (in October 2013) the implementation of Biggert-Waters for SRL properties. These rates are dependent on the characteristics of the home's basement or crawlspace. 75% of both SRL and non-SRL properties in the Restricted Sample fall into the category "no basement". The building rates corresponding to this category are provided in Table 2 for the time period between October 2008 and December 2018.

Appendix F Additional information on home and policy characteristics

Table 14: Control variables

Variable	Description
CRS Score	The community's score on the Community Rating System (CRS). The CRS is a voluntary program that rewards communities for taking actions to mitigate flood risk beyond minimum NFIP requirements. Community actions reduce policyholder premiums by up to 45%. The CRS score is the associated premium reduction, ranging from 0 (no mitigation) to 45 (maximum mitigation).
Elevation Certificate	Home elevation is sometimes estimated by communities; however, homeowners can also contract an engineer or surveyor to evaluate their homes. This variable can take 12 values depending on who assessed the elevation and when.
Elevation Indicator	A building that has no basement and that has its lowest elevated floor raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns.
Floors	Number of floors in the home, taking four possible values: 1, 2, 3 or more, or split-level.
Home Age	Age of the home, in years.
Income (ZIP code)	Mean income on the ZIP code level.
Loading factor	Fraction of the home's insurance premium and its expected claims payments.
Mobile	Indicates whether the structure is a manufactured/mobile home.
Obstruction	Description for elevated buildings regarding the area and machinery attached to the building below the lowest floor. It takes 13 values, depending on the size of the area, whether it has permanent walls, and the presence/location of machinery (e.g., if it is elevated). We include dummy variables for these in our models.
Policy Age	Age of the insurance policy with respect to original new business year.

Notes: NFIP (2014) provides additional information on these variables. Each of these variables occurs as control variable in our regression models in Section 3.1 and 3.2.

Appendix G Additional information on the estimation of loading factors

Using claims-level, panel data between 2001 and 2012, we estimate loading factors for each property. In the following, we provide the details of our frequency-severity loss estimation model. For both building and contents damage we separately fit a generalized linear model for the frequency and severity of claims in dependence of the SRL indicator, and several control variables (CRS score, elevation certificate, elevation indicator, home age, mobile, obstruction (see Table 14 in Appendix 2.3.4 for further details), elevation difference to 100-year flood event, and state characteristics on the distance to the coast, precipitation, and share of water).

We employ a Poisson GLM with logarithmic link function for the frequency of building damages ($losses_b$) and contents damages ($losses_c$):

$$\mathbb{E}[losses_j] = \exp(\beta \cdot SRL + \gamma \cdot controls) + \varepsilon, \qquad j \in \{b, c\} \tag{9}$$

For the severity of building damages ($size_b$) and contents damages ($size_c$) we use a Gamma GLM with logarithmic link function:

$$\mathbb{E}[size_j] = \exp(\beta \cdot SRL + \gamma \cdot controls) + \varepsilon, \qquad j \in \{b, c\} \tag{10}$$

Given the estimates for the frequency and severity of building and using the commonly made independence assumption of claims frequency and severity, we calculate a property's expected loss as follows:

$$expected\_loss = \mathbb{E}[losses_b] \cdot \mathbb{E}[size_b] + \mathbb{E}[losses_c] \cdot \mathbb{E}[size_c] \tag{11}$$

We additionally obtain the policyholder's expected payment by subtracting the property's deductibles for building ($deductible_b$) and contents coverage ($deductible_c$):

$$expected\_payment = indicator_b \cdot \mathbb{E}[losses_b] \cdot \max(\mathbb{E}[size_b] - deductible_b, 0) \tag{12}$$

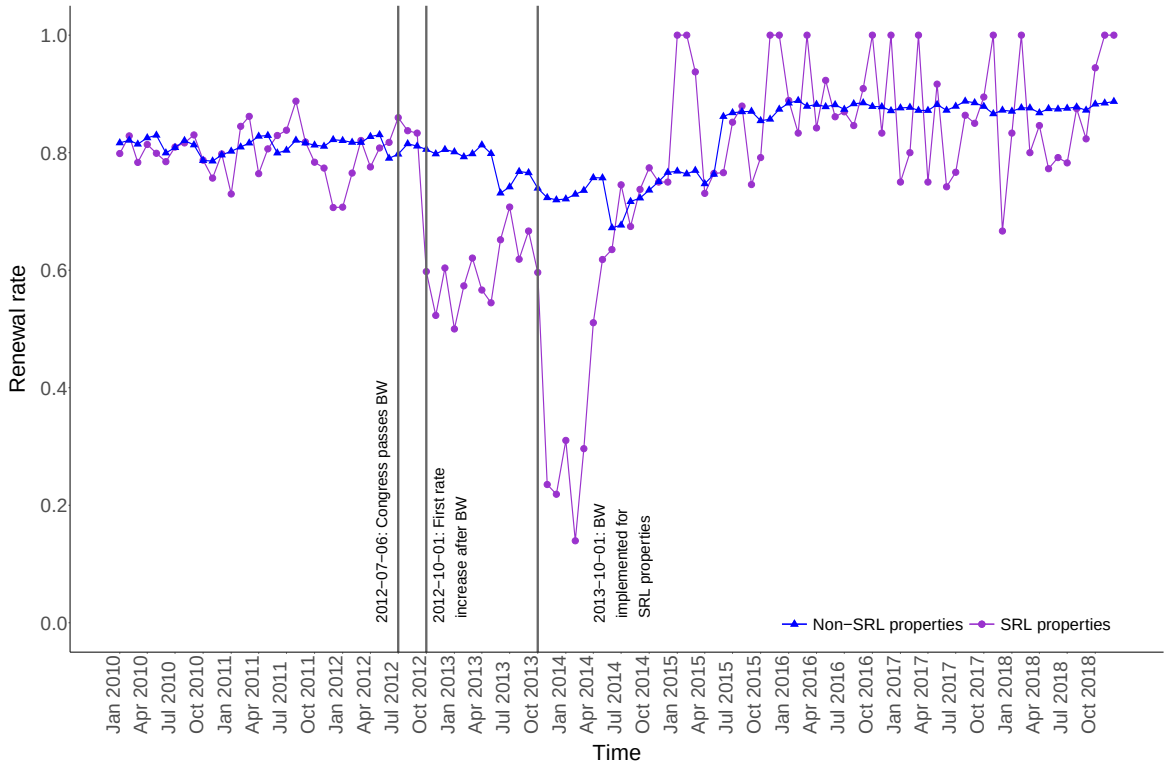
$$+ indicator_c \cdot \mathbb{E}[losses_c] \cdot \max(\mathbb{E}[size_c] - deductible_c, 0) \tag{13}$$

Finally, we get loading factors by dividing the policy's premium by the policyholder's expected payment:

$$loading\_factor = premium / expected\_payment \tag{14}$$

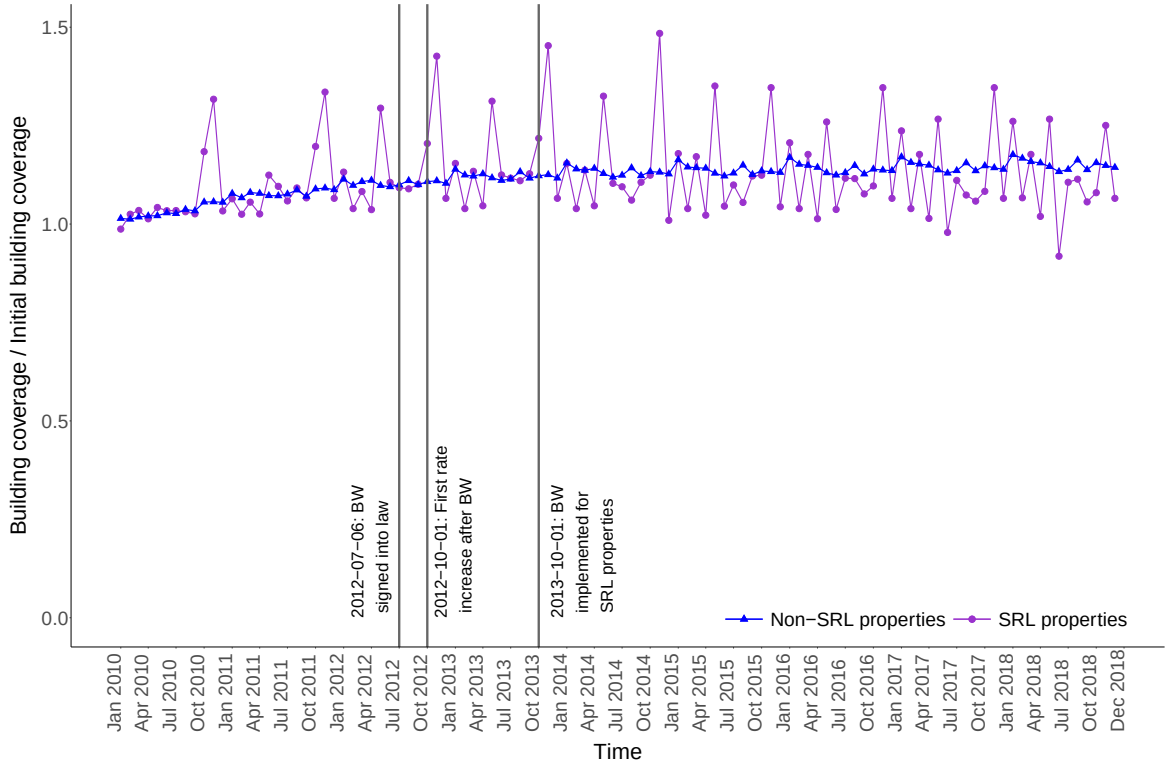
Appendix H Additional graphical representations

Figure 9: Renewal rates of the 2009 policy cohort between 2010 and 2018



Notes: The renewal rates of the 2009 policy cohort between January 2010 and December 2018 is displayed. For both SRL and non-SRL properties we calculate renewal rates at time t by dividing the number of policies that were renewed at time t by the number of policies that were in force one year before. For example, about 80% of both SRL and non-SRL properties that were active in September 2011 were renewed in September 2012. The renewal rates of SRL and non-SRL properties exhibit parallel trends before the ratification of Biggert-Waters on July 6, 2012. The larger month-to-month variation in renewals for SRL properties occurs because the sample of SRL properties is much smaller than that of non-SRL properties. In 2010, for example, we observe renewal decisions of 2,050 SRL property owners and 476,631 non-SRL property owners. The NFIP implemented a premium increase on 1 October 2012 – after the law was passed, but before SRL and non-SRL properties were charged different prices. Even though this October 2012 premium increase affected SRL and non-SRL properties similarly, SRL properties dropped from a renewal rate of 80% in September 2012 to a rate of 60% in October 2012. Following October 2012 and until October 2013, SRL property owners continued to renew their policies at rates around 60%. In contrast, non-SRL property owners' renewal rates remained effectively constant during this period. An additional drop in renewal rates begins on 1 October 2013, the point at which Biggert-Waters price increases for SRL properties were implemented. Only 20% of policies that were in force in November 2012 were renewed in November 2013. Finally, after October 2014 renewal rates of SRL policies matched almost those of non-SRL policies and reached levels of about 80% again. The renewal rate appears slightly higher at the end of the time series than at the beginning. One explanation for this pattern is that the subset of the cohort that remains insured throughout the time series is especially likely to renew.

Figure 10: Coverage choices of the 2009 policy cohort renewing each year between 2010 and 2018



Notes: The evolution of coverage choices of the 2009 policy cohort renewing each year between 2010 and 2018 is displayed. For both SRL and non-SRL properties we measure coverage choices at time t by dividing the chosen building coverage at time t by the building coverage chosen in 2009. In contrast to extensive margin decisions, on the intensive margin, almost no differential behavior between the SRL properties and the reference group can be observed at the first renewal decisions after the ratification of Biggert-Waters on July 6, 2012.

Appendix I Robustness checks

Table 15: Regression results: Renewal decisions of the 2010 policy cohort between 2011 and 2018

	Dependent variable:		
	renewal indicator		
	(1)	(2)	(3)
SRL:FY_11	0.0160	0.0164	0.0066
	(0.0155)	(0.0155)	(0.0152)
SRL:FY_13	-0.1551^{***}	-0.1548^{***}	-0.1678^{***}
	(0.0216)	(0.0215)	(0.0249)
SRL:FY_14	-0.1648^{***}	-0.1638^{***}	-0.2359^{***}
	(0.0357)	(0.0358)	(0.0459)
SRL:FY_15	0.0626^{***}	0.0651^{***}	-0.0594^{*}
	(0.0212)	(0.0213)	(0.0324)
SRL:FY_16	0.0407^{***}	0.0441^{***}	-0.0786^{***}
	(0.0136)	(0.0137)	(0.0287)
SRL:FY_17	-0.0308	-0.0263	-0.1542^{***}
	(0.0214)	(0.0214)	(0.0404)
SRL:FY_18	0.0027	0.0080	-0.1348^{***}
	(0.0285)	(0.0282)	(0.0450)
SRL	-0.0073	-0.0083	
	(0.0145)	(0.0144)	
Controls	Yes	Yes	Yes
ZIP FE	Yes	Yes	No
Month FE	Yes	Yes	Yes
Fiscal Year FE	No	Yes	Yes
Individual FE	No	No	Yes
Clustered SE	State	State	State
Observations	1,793,464	1,793,464	1,793,464
R^2	0.0602	0.0601	0.4839
Adjusted R^2	0.0514	0.0513	0.3199
Residual Std. Error	0.3836	0.3836	0.3248

Notes: We estimate the renewal regressions using the 2010 cohort, instead of the 2009 cohort (see Table 9). Dependent variable is the renewal indicator variable. Fiscal year (FY) 2012 is the reference category. Column (1) gives the results of a linear probability model including ZIP and month fixed effects as well as a quadratic monthly time trend. Column (2) modifies the model given in column (1) and uses fiscal year fixed effects instead of a quadratic time trend. Finally, column (3) extends column (2) in replacing ZIP fixed effects with individual fixed effects. All models include home and policy characteristics as control variables. Standard errors, heteroscedasticity-robust and clustered by state, are in parentheses.

Table 16: Regression results: Coverage choices of the 2009 policy cohort renewing each year between 2010 and 2018

	Dependent variable:		
	coverage choice		
	(1)	(2)	(3)
SRL:FY_10	−0.0132	−0.0124	−0.0112
	(0.0292)	(0.0290)	(0.0184)
SRL:FY_11	−0.0054	−0.0047	−0.0046
	(0.0159)	(0.0160)	(0.0158)
SRL:FY_13	0.0046	0.0039	0.0004
	(0.0060)	(0.0060)	(0.0086)
SRL:FY_14	−0.0236**	−0.0250**	−0.0285**
	(0.0120)	(0.0120)	(0.0123)
SRL:FY_15	−0.0366**	−0.0388**	−0.0409**
	(0.0153)	(0.0154)	(0.0163)
SRL:FY_16	−0.0448**	−0.0476**	−0.0513**
	(0.0186)	(0.0185)	(0.0232)
SRL:FY_17	−0.0721***	−0.0757***	−0.0819***
	(0.0211)	(0.0210)	(0.0298)
SRL:FY_18	−0.0830***	−0.0873***	−0.1029***
	(0.0263)	(0.0261)	(0.0345)
SRL	−0.0041	−0.0027	
	(0.0853)	(0.0852)	
Controls	Yes	Yes	Yes
ZIP FE	Yes	Yes	No
Month FE	Yes	Yes	Yes
Fiscal Year FE	No	Yes	Yes
Individual FE	No	No	Yes
Clustered SE	State	State	State
Observations	712,522	712,522	712,522
R^2	0.1144	0.1144	0.7848
Adjusted R^2	0.1029	0.1029	0.7577
Residual Std. Error	0.4966	0.4966	0.2581

Notes: Dependent variable is the ratio of building coverage and building coverage chosen in 2009. Fiscal year (FY) 2012 is the reference category. Column (1) gives the results of a pooled ordinary least squares model including ZIP and month fixed effects as well as a quadratic monthly time trend. Column (2) modifies the model given in column (1) and allows for fiscal year fixed effects instead of a quadratic time trend. Finally, column (3) extends column (2) in replacing ZIP fixed effects with individual fixed effects. All models include home and policy characteristics as control variables. Standard errors, heteroscedasticity-robust and clustered by state, are in parentheses.

Table 17: Regression results: Coverage choices of the 2010 policy cohort renewing each year between 2011 and 2018

	Dependent variable:		
	coverage choice		
	(1)	(2)	(3)
SRL:FY_11	0.0038	0.0039	−0.0006
	(0.0174)	(0.0173)	(0.0199)
SRL:FY_13	−0.00005	−0.0006	−0.0040
	(0.0038)	(0.0038)	(0.0040)
SRL:FY_14	−0.0169*	−0.0180*	−0.0216**
	(0.0098)	(0.0098)	(0.0095)
SRL:FY_15	−0.0202*	−0.0218**	−0.0243**
	(0.0104)	(0.0105)	(0.0101)
SRL:FY_16	−0.0280**	−0.0302**	−0.0348**
	(0.0124)	(0.0126)	(0.0144)
SRL:FY_17	−0.0527***	−0.0554***	−0.0616***
	(0.0147)	(0.0148)	(0.0206)
SRL:FY_18	−0.0647***	−0.0680***	−0.0857***
	(0.0169)	(0.0169)	(0.0219)
SRL	−0.0030	−0.0016	
	(0.0635)	(0.0634)	
Controls	Yes	Yes	Yes
ZIP FE	Yes	Yes	No
Month FE	Yes	Yes	Yes
Fiscal Year FE	No	Yes	Yes
Individual FE	No	No	Yes
Clustered SE	State	State	State
Observations	712,622	712,622	712,622
R^2	0.1095	0.1094	0.7421
Adjusted R^2	0.0971	0.0970	0.7051
Residual Std. Error	0.3815	0.3816	0.2180

Notes: We estimate the coverage choice regressions using the 2010 cohort, instead of the 2009 cohort (see Table 16). Dependent variable is the ratio of building coverage and building coverage chosen in 2010. Fiscal year (FY) 2012 is the reference category. Column (1) gives the results of a pooled ordinary least squares model including ZIP and month fixed effects as well as a quadratic monthly time trend. Column (2) modifies the model given in column (1) and allows for fiscal year fixed effects instead of a quadratic time trend. Finally, column (3) extends column (2) in replacing ZIP fixed effects with individual fixed effects. All models include home and policy characteristics as control variables. Standard errors, heteroscedasticity-robust and clustered by state, are in parentheses.

Table 18: Regression results: Coverage choices of the 2009 policy cohort between 2010 and 2018

	Dependent variable:		
	coverage choice		
	(1)	(2)	(3)
SRL:FY_10	-0.0520^{**}	-0.0521^{**}	-0.0556^{*}
	(0.0249)	(0.0248)	(0.0333)
SRL:FY_11	-0.0494^{*}	-0.0490^{*}	-0.0450
	(0.0262)	(0.0261)	(0.0306)
SRL:FY_13	-0.0431	-0.0437	-0.0385^{*}
	(0.0306)	(0.0306)	(0.0203)
SRL:FY_14	-0.0372	-0.0394	-0.0473^{***}
	(0.0365)	(0.0366)	(0.0150)
SRL:FY_15	-0.0473	-0.0506	-0.0547^{**}
	(0.0484)	(0.0487)	(0.0235)
SRL:FY_16	-0.0912^{***}	-0.0959^{***}	-0.0807^{***}
	(0.0334)	(0.0339)	(0.0161)
SRL:FY_17	-0.1010^{***}	-0.1066^{***}	-0.0953^{***}
	(0.0345)	(0.0350)	(0.0151)
SRL:FY_18	-0.1029^{***}	-0.1095^{***}	-0.1152^{***}
	(0.0312)	(0.0324)	(0.0170)
SRL	0.0748^{**}	0.0756^{**}	
	(0.0382)	(0.0382)	
Controls	Yes	Yes	Yes
ZIP FE	Yes	Yes	No
Month FE	Yes	Yes	Yes
Fiscal Year FE	No	Yes	Yes
Individual FE	No	No	Yes
Clustered SE	State	State	State
Observations	1,648,574	1,648,574	1,648,574
R^2	0.0355	0.0355	0.8281
Adjusted R^2	0.0262	0.0261	0.7775
Residual Std. Error	0.6800	0.6800	0.3250

Notes: We estimate the coverage choice regressions using all choices of the 2009 cohort between 2010 and 2018, instead of the choices for the subset of the 2009 cohort that continued to insure at the end of the panel dataset (see Table 16). Dependent variable is the ratio of building coverage and building coverage chosen in 2009. Fiscal year (FY) 2012 is the reference category. Column (1) gives the results of a pooled ordinary least squares model including ZIP and month fixed effects as well as a quadratic monthly time trend. Column (2) modifies the model given in column (1) and allows for fiscal year fixed effects instead of a quadratic time trend. Finally, column (3) extends column (2) in replacing ZIP fixed effects with individual fixed effects. All models include home and policy characteristics as control variables. Standard errors, heteroscedasticity-robust and clustered by state, are in parentheses.